MERCURY DEPOSITION AND RISK ASSESSMENT
SANTEE COOPER ▪ PEE DEE, SOUTH CAROLINA

FLORENCE COUNTY, SOUTH CAROLINA

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1. EXECUTIVE SUMMARY

Santee Cooper has proposed to construct a new, coal-fired power plant near Kingsburg, SC (Pee Dee facility). The proposed facility will consist of two pulverized coal boilers and ancillary support equipment. The necessary Prevention of Significant Deterioration (PSD) permitting and air quality analyses have been performed and approved and a final permit has been issued by the South Carolina Department of Health and Environmental Control (DHEC).[1] In addition, a human health risk assessment was conducted to provide an estimate of the potential health impacts of mercury (Hg) emissions from the Pee Dee facility. This report contains the details of air dispersion modeling and human health risk assessment study including methods, assumptions, and predicted impacts.

Risk Assessment is defined as the scientific evaluation of potential health impacts that may result from exposure to a particular substance or mixture of substances under specified conditions.[2] Standard USEPA risk assessment techniques were used to assess whether these predicted chemical emissions might present a risk to human health. These documents primarily include the 1) U.S. EPA's Mercury Report to Congress, 2) USEPA Human Health Risk Assessment Protocol (HHRAP), and 3) USEPA Air Toxics Risk Assessment Reference Library (ATRL) (Volume 2, Facility-Specific Assessment). These documents contain the methodology guidance, fate and transport, exposure and health risk algorithms for predicting the impacts of mercury released into the environment from combustion sources.

The risk assessment approach was divided into two stages: a) screening-level risk analysis and b) refined risk analysis. Methodologies used to perform the screening-level risk analysis were based on the ATRL screening level approach and additional consideration of simplified fate and transport equations presented in the HHRAP. The screening-level assessment was intended to provide a highly conservative estimate of potential health impacts and to identify opportunities for reducing uncertainty through incorporating site-specific data. To this end, a refined risk assessment was performed and is the focus of this report. The refined risk analysis fully implements the HHRAP guidance which includes specific methodology for modeling the fate and transport of mercury emissions from combustion sources and includes detailed consideration of site-specific factors that influence exposure and risk. These approaches are discussed in detail in Section 4.

The human health risk assessment approach is split into 5 important steps:

1. Identifying Compounds of Potential Concern (COPC) (Section 2.1)

2. Identifying Emission rates and Sources (Section 2.2)

3. Selecting Exposure Scenario (Section 2.3)

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[1] Bureau of Air Quality, DHEC, *PSD, NSPS (40CFR60), NESHAP (40CFR63) construction permit*, December 16, 2008 (URL: http://www.scdhec.gov/environment/baq/docs/SanteeCooper/permit_2008-12-16.pdf.) All permit-related documents are available at http://www.scdhec.gov/environment/baq/SanteeCooper.aspx.

[2] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Chapter 1, Section 1.5, p. 1-17 (URL: http://www.epa.gov/combustion/risk.htm).

4. Estimating Media Concentrations, Exposure and Risk (Section 4)
5. Identifying and Interpreting Uncertainty (Section 5)

The risk assessment methodologies prescribed in various USEPA risk assessment documents are designed to over-estimate, rather than under-estimate health risks. As recommended in the HHRAP, facility-, site-, and chemical-specific data were used as inputs in the fate and transport and exposure equations. While it is acknowledged that this approach is intended to reduce uncertainty, the HHRAP also provides numerous recommended default parameters, which are by design, intended to be conservative. The use of HHRAP recommended defaults and other key assumptions described throughout this report, likely lead to higher than actual exposure estimates.

As demonstrated in this report, the small amount of mercury introduced into the environment from Pee Dee facility emissions is well below the hazard target level. Thus, because the results of the risk analysis indicate health risks are well below target levels, and since risks from plant operations do not significantly increase health risks in the area, there is confidence in the conclusion that health risk attributable to exposure from air toxics resulting from the operations of the proposed facility is unlikely. Results of this human health risk assessment also reinforce the significant level of human health protectiveness offered by the DHEC approved mercury permit limit.

2. MERCURY EMISSIONS AND EXPOSURE SCENARIOS

2.1 IDENTIFYING COMPOUNDS OF POTENTIAL CONCERN (COPC)

The primary compound of potential concern (COPC) associated with coal combustion emissions is mercury and is the focus of this air dispersion modeling and human health risk assessment study. General information supporting the inclusion of mercury as a COPC when conducting human health risk assessments for evaluating potential impacts from combustion facilities is readily available in the open literature and numerous USEPA publications. Detailed information is provided in the USEPA Mercury Report to Congress, USEPA HHRAP, and the USEPA Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units Report to Congress.

The fate and transport of mercury in the environment is a complex process. Mercury is a natural constituent of the environment and moves through various environmental media depending on the chemical form of mercury and a multitude of site-specific factors influencing environmental chemistry. Mercury is emitted to the atmosphere by a variety of sources including natural processes and anthropogenic sources including coal combustion. Once in the environment mercury is subjected to chemical and biological reactions which influence what forms are present and in what concentrations. The chemical form of mercury determines not only how it moves through the media, but also influences its bioavailability and toxicity characteristics. From a human health exposure perspective, organic forms of mercury such as methylmercury are believed to have the highest potential for causing human health effects due to potential bioaccumulation in fish.

The following section is summarized from the USEPA Mercury Report to Congress and provides a general overview of the mechanisms involved in the movement of mercury in the environment.[3] Once released into the air from the emission source, the movement of mercury is influenced by numerous factors including 1) chemical transformation, 2) dispersion, 3) transport, 4) deposition, and 5) transfer between or binding by media including air, soil, water and sediment. Mercury has been shown to be widely dispersed in the atmosphere upon release from a combustion source and can be transported thousands of miles from the initial point of release. The distance of this transport and eventual deposition to the surface depends on source characteristics, local land use, the physical and chemical form of the mercury emitted and the influence of local, regional, and global meteorological conditions. Studies indicate that the residence time of elemental mercury in the atmosphere may be on the order of a year or more, allowing its distribution over long distances. The residence time of oxidized mercury compounds (e.g., mercuric chloride) in the atmosphere is uncertain, but is generally believed to be on the order of a few days. Once mercury is deposited, it is commonly emitted back to the atmosphere either as a gas or in association with particulates to be re-deposited elsewhere. Mercury undergoes a series of complex chemical and physical transformations as it cycles among the atmosphere, soil, plants, water and sediment.

The HHRAP guidance includes methodologies and equations specifically designed to model these complex processes; and to estimate potential human health risks associated with mercury exposure from combustion sources. Consistent with the HHRAP and other individually referenced USEPA documents, total mercury is speciated into both elemental and divalent forms and allocated into vapor

[3] U.S. EPA, *Mercury Study Report to Congress Volume III, Fate and Transport of Hg in the Environment,* December 1997. EPA452/R-97-005.

and particle bound phases during air dispersion modeling. Elemental mercury is modeled in the vapor phase and assessed through the direct inhalation exposure pathway. Divalent mercury is modeled in both vapor and particle-bound phases and assessed through both direct and indirect exposure pathways. Divalent mercury is represented in the estimating media concentration exposure equations using the fate and transport parameters for mercuric chloride. As described earlier in this section the methylation of mercury is of primary interest from a human health exposure perspective. Methylmercury is modeled by applying media-specific apportionment factors to mercuric chloride concentrations to account for the fraction of mercuric chloride that is converted into methylmercury. To remain consistent with USEPA guidance, and represent the complex movement of mercury in the environment, elemental mercury, mercuric chloride and methylmercury were selected as COPCs and quantitatively evaluated in the risk assessment to assess potential health impacts from direct inhalation and indirect exposure through the fish ingestion and drinking water pathways.

Although mercury was selected as the primary COPC for conducting the multi-pathway human health risk assessment, other potential HAP emission from the Pee Dee plant were also considered. The EPA has not set national ambient air quality standards for HAP emissions. Therefore, there are no national ambient standards to use in accessing the impacts of HAP emissions of the Pee Dee plant. South Carolina, however, has established maximum allowable ambient concentrations (MAAC) for air toxics emissions under S. C. Regulation 61-62.5, Standard No. 8 - Toxic Air Pollutants (Standard No. 8). MAACs were established to specify the appropriate ambient levels for the protection of public health. In addition to the screening level and refined risk analysis completed for mercury, potential health impacts associated with other facility reported HAP emissions were evaluated by comparing maximum modeled 24-hour air concentrations to the applicable MAAC standards. Results of this analysis demonstrate that all chemical specific 24-hour air concentrations are well below MAAC standards. The calculated percentage of MAAC standards ranges between less than 0.01 percent to a maximum of 1.09 percent for beryllium. Detailed results of this analysis are provided in Appendix A.

2.2 IDENTIFYING EMISSION RATES AND SOURCES

The proposed facility will consist of two pulverized coal-fired boilers and ancillary support equipment. The boilers will nominally provide 660 MW of power each. They will be identical boilers each with a nominal heat input capacity of 5,700 MMBtu/hr. Emission from both boilers will be routed through a common stack. The facility will be using Eastern Bituminous coal for power production. Control technology options designed to reduce stack emissions including mercury include a selective catalytic reduction (SCR) system, a wet flue gas desulfurization (WFGD), and a fabric filter. Mercury emissions from a single boiler were proposed to be limited to 57.8 pounds per year (lb/yr).[4] However, in the final permit issued by DHEC, mercury emissions for a single boiler were revised to be 46.3 lbs/yr.[5] Given the timing (the final permit was not issued until this report was in final review phase) and considering risk assessment objectives, the higher emission rate limit of 57.8 lbs/yr emission for each boiler was used in air dispersion modeling and subsequent risk (both screening and refined) analyses and provides additional conservatism. Therefore, the total mercury emission rate used during modeling was 115.6 lbs/yr (57.8 lbs per year per boiler for a total of two boilers).

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[4] *Santee Cooper Case-by-Case MACT Permit Application*, June 30, 2008 (URL: http://www.scdhec.net/environment/baq/docs/SanteeCooper/SanteeCooperCasebyCaseApplicationforPeeDee.pdf).

[5] Bureau of Air Quality, DHEC, *PSD, NSPS (40CFR60), NESHAP (40CFR63) construction permit*, December 16, 2008 (URL: http://www.scdhec.gov/environment/baq/docs/SanteeCooper/permit_2008-12-16.pdf.) All permit-related documents are available at http://www.scdhec.gov/environment/baq/SanteeCooper.aspx.

Additional conservatism is achieved by the fact that even the 46.3 lb/yr emission limit is a maximum value and should rarely be reached. As part of the permitting process, the emissions limit was required to be set at a level that would be achievable under the worst-foreseeable operating conditions over the lifetime of the Pee Dee units. Thus, the average emission rate (which is the more relevant value for a risk analysis) would be less than (and potentially much less than) the permit limit.

As recommended in the HHRAP and other individually referenced documents, final selection of COPCs included elemental mercury, divalent mercury modeled as mercuric chloride and methylmercury. The screening level assessment focused solely on methylmercury, while the refined level assessment included all three mercury forms. Total mercury emissions were speciated into both elemental and mercuric chloride to calculate chemical specific emission rates. Details regarding the calculation of emission rates are provided in Section 2.2.2. Air dispersion modeling details are provided in Section 3.0. Figure 2-1 illustrates the speciation and phase allocation for the mercury emissions exiting the stack from proposed facility operations.

2.2.1 Mercury Global Cycle

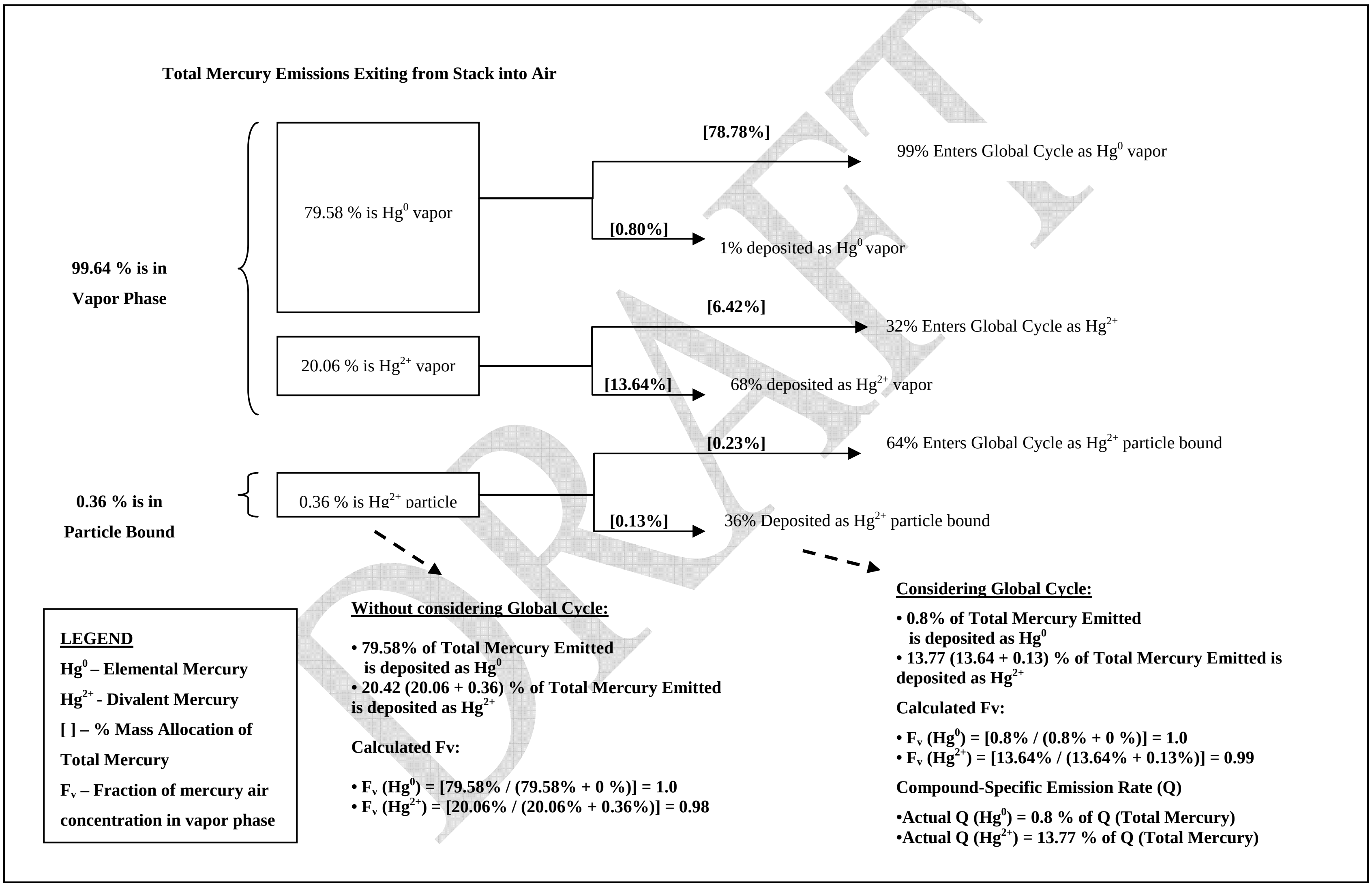
As presented in the HHRAP a vast majority of mercury exiting the stack doesn't readily deposit, but is vertically diffused to the free atmosphere, transported outside the study area and into the global cycle.[6] Loss to the mercury global cycle was not considered in the initial screening risk analysis to provide more conservative estimates. However, consideration of the mercury global cycle was included in the refined risk assessment in order to develop more representative site-specific estimates. Figure 2-1 depicts the representative speciation and phase allocation used to perform air dispersion and risk modeling for mercury emissions exiting the stack from the proposed facility. The HHRAP recommends using a default loss to global mercury cycle for individual species of mercury as specified below.[7]

- 99% of the vapor-phase elemental mercury becomes part of the global cycle and the remaining 1% has the potential to be deposit locally.
- 32% of the vapor-phase divalent mercury diffuses vertically and becomes a part of the global cycle and the remaining 68% has the potential to be deposit locally.
- 64 % of the particle bound divalent mercury diffuses vertically and becomes part of the global cycle and the remaining 36 % has the potential to be deposit locally.

[6] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Chapter 2, Section 2.3.5.3, p. 2-51.

[7] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Chapter 2, Section 2.3.5.3, p. 2-51.

FIGURE 2-1. PHASE ALLOCATION AND SPECIATION OF MERCURY IN AIR



2.2.2 PHASE AND SPECIATION ALLOCATION FOR MERCURY EMISSIONS

The chemical form of mercury emitted from the stack is a critical factor in determining its fate, transport and toxicity in the environment. Mercury speciation profiles provided in the HHRAP define the estimated fraction of mercury emitted as either elemental mercury, Hg(0) or divalent mercury, Hg(II). To reduce uncertainty, the HHRAP recommends using site-specific or representative mercury speciation data when estimating dispersion and deposition. The speciation of mercury is thought to be highly variable not only among source types, but also between individual industrial facilities. For this reason, actual speciation test data from representative source types were reviewed and used instead of the default speciation allocation as outlined in the HHRAP. Mercury speciation test results for 73 coal-based power plants in the United States were reviewed. These test results were originally made available as part of an information request by the US EPA for the Utility National Emission Standards for Hazardous Air Pollutants (NESHAP).[8]

Of the Santee Cooper control technology devices, the WFGD has the greatest influence on mercury speciation because it is efficient in removal of the divalent mercury which is ionic and readily soluble in water. Therefore, to reduce uncertainty and ensure representativeness, test results were selected for those facilities exhibiting similar characteristics including burning eastern bituminous coal and where a WFGD was being utilized for SO_2 control.

Three plants met the above mentioned criteria including the Bruce Mansfield power plant, Clover power plant, AES Cayuga plant.[9,10,11] The actual concentration values from the stack test results from the three power plants are presented in Table 2-1.

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[8] Speciated Mercury Emission Test Reports (URL: http://www.epa.gov/ttn/atw/combust/utiltox/mercury.html).

[9] Source Emissions Survey of Pennsylvania Power Company, Bruce Mansfield Power Plant, Unit Number 1B Scrubber Inlet and 1A Stack by METCO Environmental, September 1999.

[10] Test Program Conducted at Virginia Power, Clover Plant Station – Unit 2, Clover, Virginia by ETS, Inc., December 1999, this plant burns bituminous coal based on Title V permit no. VA-30867, this coal type is assumed to be eastern bituminous based on plant location.

[11] Program Results from a Comprehensive Assessment of Chemical Emissions from AES Cayuga (formerly NYSEG Milliken), Unit 2, Lansing, New York by CARNOT, July 1997.

TABLE 2-1. STACK TEST RESULTS FOR MERCURY SPECIES FOR POWER PLANTS FIRING EASTERN BITUMINOUS COAL WITH WFGD

Plant Name	Hg(II) - Particle-bound Phase Outlet Concentration (µg/dscm)	Hg(II) Vapor Phase Outlet Concentration (µg/dscm)	Hg(Elemental) Vapor Phase Outlet Concentration (µg/dscm)
Bruce Mansfield	0.04	1.50	6.00
AES Cayuga (formerly NYSEG Milliken)	6.00E-03	0.61	2.40
Clover Power Station	0.03†	0.17†	0.19

† Indicates a non-detectable concentration value in stack tests.

Test results for the Clover power plant, for divalent mercury in the particulate-bound and vapor phase were below detection limits and therefore not included in final speciation profile. The mercury speciation (%) for the remaining representative sets of selected test results (Bruce Mansfield, AES Cayuga plants) are presented in Table 2-2.

TABLE 2-2. SUMMARY OF MERCURY SPECIATION FOR POWER PLANTS FIRING EASTERN BITUMINOUS COAL WITH WFGD

Plant Name	Test Method	Hg(II) - Particle-bound Phase Outlet Concentration (µg/dscm)	Hg(II) Vapor Phase Outlet Concentration (µg/dscm)	Hg(Elemental) Vapor Phase Outlet Concentration (µg/dscm)
AES Cayuga (formerly NYSEG Milliken)	EPA Method 29	0.20%	20.23%	79.58%
Bruce Mansfield	Ontario Hydro Method	0.53%	19.89%	79.58%
Average		0.36%	20.06%	79.58%

At the stack outlet, elemental mercury dominates the mercury speciation profile, with an average fraction of 79.6% of the total mercury concentration. Divalent vapor phase mercury forms the next largest fraction and divalent particle-bound phase mercury comprises the remaining fraction. The divalent particle-bound and vapor phase concentrations are much lower in comparison to elemental mercury particularly due to the presence of the WFGD system and particulate matter controls. Using this speciation profile, Table 2-3 shows the speciated emission rates that were utilized in the screening level risk assessment.

TABLE 2-3. SPECIATED MERCURY EMISSION RATES – SCREENING LEVEL ANALYSIS

Source	Total Hg Emission Rate		Effective (Actual) Emission Rate[1] (Loss to Global Cycle is not considered)	
	Hg Emission Rate (lb/yr)	*Hg Emission Rate (g/s)*	*Total Hg(II) Emission Rate (g/s)*	*Total Hg(Elemental) Emission Rate (g/s)*
Boiler 1	57.8	8.31E-04	1.70E-04	6.62E-04
Boiler 2	57.8	8.31E-04	1.70E-04	6.62E-04
Total	115.6	1.66E-03	3.40E-04	1.32E-03

[1]As described in Figure 2-1, when Loss to Global Cycle is not considered, Hg(II) emission rate is 20.42 % of total Hg emission rate and Hg(0) emission rate is 79.58 % of total Hg emission rate.

Table 2-4 shows the speciated emission rates adjusted for consideration of loss to the mercury global cycle and utilized in the refined risk analysis.

TABLE 2-4. SPECIATED MERCURY EMISSION RATES – REFINED ANALYSIS

Source	Total Hg Emission Rate		Effective (Actual) Emission Rate[1] (Loss to Global Cycle is considered)	
	Hg Emission Rate (lb/yr)	*Hg Emission Rate (g/s)*	*Total Hg(II) Emission Rate (g/s)*	*Total Hg(Elemental) Emission Rate (g/s)*
Boiler 1	57.8	8.31E-04	1.14E-04	6.65E-06
Boiler 2	57.8	8.31E-04	1.14E-04	6.65E-06
Total	115.6	1.66E-03	2.29E-04	1.33E-05

[1]As described in Figure 2-1, when Loss to Global Cycle is considered, Hg(II) emission rate is 13.77 % of total Hg emission rate and Hg(0) emission rate is 0.08 % of total Hg emission rate.

2.3 EXPOSURE SCENARIO SELECTION

Exposure scenarios presented in the HHRAP are intended to estimate the type and magnitude of human exposure typical of emission from combustion sources. An exposure scenario is a combination of exposure pathways to which a human receptor may be subjected. The exposure scenarios recommended in the HHRAP are designed with a level of protectiveness and are intended to be representative of not only the general public, but also populations with somewhat higher exposures.

Based on consideration of current and reasonable potential future human exposure activities in the assessment area (i.e., area surrounding the facility) and based on the knowledge that U.S. EPA considers the primary exposure pathway (99.9%) for humans to methylmercury to be from the ingestion of fish[12], the Fisher Adult and Fisher Child exposure scenarios were selected as the basis for estimating potential human health impacts. Although not considered significant, mercury exposure in humans may also occur through other routes of exposure such as drinking water and inhalation. To remain conservative and consistent with the HHRAP, the drinking water and inhalation exposure pathways were also included in the refined assessment.

The Fisher exposure scenario (including adult and child) is intended to represent typical exposures in an urban or nonfarm rural setting, including limited exposure through recreational fishing. In contrast, the subsistence fisher exposure scenario is intended to represent a much smaller portion of the population where fish ingestion comprises the major source of protein in the person's diet. The primary difference between the fishing and subsistence fishing scenarios is the higher consumption rates for the subsistence fishing scenarios. While no information was identified to indicate the presence of subsistent fishing in the project area, the subsistent fishing scenario was included in the refined analysis to remain conservative and to account for potential future human activities.

In addition to the selection of representative exposure scenarios, the selection of which surface water bodies to include in the analysis is also an important consideration. Details concerning the selection process and identification of specific watersheds for inclusion in this modeling study are discussed in Sections 3.0 and 4.0 of this report.

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[12] U.S. EPA, *Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion*, August 2006, EPA 823-B-04-001, Section 3.2.1.1, p. 27. (URL: http://www.epa.gov/waterscience/criteria/methylmercury/guidance-draft.html)

3. AIR DISPERSION MODELING

As discussed in Section 2.1, movement of mercury in the environment is a complex process. Air dispersion modeling is performed to account for the transport, diffusion, and deposition of mercury in the environment once emissions leave the stack. This step is accomplished using the USEPA approved air dispersion model, AERMOD and is the primary subject of this section. The results of the air dispersion modeling analysis, along with chemical-specific fate and transport variables, provide the necessary inputs into the estimating media and exposure equations used in the HHRAP. These equations are specifically designed to account for the movement of chemicals, including mercury, within and between media including air, soil, water and sediment. Section 4.0 provides the details of fate and transport and exposure modeling.

As further discussed in Section 2.1, the predominant exposure pathway for evaluating potential exposure to mercury is ingestion of fish. Exposure through the fish ingestion pathway is driven by the concentration in water. The first step in estimating the surface water concentration, and ultimately the mercury concentration in fish, is to estimate the amount of mercury released from the facility that is deposited either directly onto surface water bodies or deposited onto associated watersheds where it can contribute to water body concentrations through loading and runoff. This section details the modeling conducted to calculate the atmospheric transfer, dispersion, and deposition of mercury from the facility. The following sections detail modeling methods, assumptions, and results.

3.1 SELECTION OF MODEL

AERMOD is a refined, steady-state, multiple source, Gaussian dispersion model and was promulgated in December 2005 as the preferred model to use for industrial sources in regulatory air quality analyses.[13] There are no regulatory procedures outlined for mercury deposition modeling which dictate specific model selection or parameter settings. The AERMOD model was selected based on its widespread use and as a recommended model in the EPA Air Toxics Risk Assessment (ATRA) library.[14]

The latest AERMOD version (07026) was used to conduct the modeling analysis. However, during initial modeling efforts conducted to support the screening level analysis, a change to the model code was required to address a distance limitation in AERMOD when running in TOXICS mode. In the current regulatory version of the code, whenever the TOXICS mode is enabled, deposition calculations are not made for receptors which are more than 80 km distant from the source. This modification was necessary during initial screening due to the extensive watershed for the Pee Dee River which extends well beyond the 80 km cutoff. This limitation would have resulted in the exclusion of potential impacts to the watershed, which would have resulted in an under-prediction of the total Hg deposition. The AERMOD code was thus modified, by changing the value on line 762 of

[13] 40 CFR 51, Appendix W–*Guideline on Air Quality Models*, Appendix A.1– AMS/EPA Regulatory Model (AERMOD).

[14] U.S. EPA, *Air Toxics Risk Assessment Library, Volume I Technical Resource Manual*, April 2004, EPA-453-K04-001A.

CALC1.for, from 80,000 to 800,000 (units of meters for the calculation cutoff) in order to resolve this limitation. A comparative analysis was performed for a subset of receptors to ensure that the modified AERMOD code yielded the same results as the regulatory version. While utilizing AERMOD to model distances greater than 50 km is beyond the intended use of the model, it is conservative for this application, since the model will predict concentrations at receptors that would only ever be exposed to pollutant mass due to long-range transport and recirculation events. The electronic files associated with the comparative analysis as well as the modified AERMOD code are included in Appendix D.

Use of the modified version of the code was not required for performing the refined risk analysis, since a smaller Pee Dee River sub-watershed area was selected that did not extend beyond 80 km. Section 4.0 provides additional details on the refined risk analysis, including a discussion on selection of watersheds, specific air modeling options, and inputs are described in the following sections.

3.2 TREATMENT OF TERRAIN

Complex terrain is defined as any terrain elevation exceeding stack top height. Complex terrain is further sub-categorized into intermediate terrain (terrain elevation less than final plume rise height) and true complex terrain (terrain elevation greater than final plume rise height). The AERMOD model simplifies the treatment of terrain, as it does not have different algorithms for varying source-receptor elevation relationships described above. Through the use of the AERMOD terrain preprocessor (AERMAP), AERMOD incorporates not only the receptor heights, but also an effective height (hill height scale) that represents the significant terrain features surrounding a given receptor that could lead to plume recirculation and other terrain interaction.[15]

Receptor terrain elevations used in modeling were interpolated from 1-Degree Digital Elevation Model (DEM) data obtained from the U.S. Geological Survey (USGS). These data consist of arrays of regularly spaced elevations and correspond to the 1:250,000 scale topographic quadrangle map series. The array elevations are at 3 arc second (roughly 90-meter) intervals and were interpolated using AERMAP, as incorporated into Trinity's *BREEZE*®-AERMOD software to determine elevations at the defined receptor intervals. All data obtained from the DEM files were checked for completeness and spot-checked for accuracy.

3.3 METEOROLOGICAL DATA

Previous modeling analyses conducted for the Pee Dee site air permitting were performed using 1987 through 1991 preprocessed meteorological data based on surface observations taken from Columbia, South Carolina (Station No. 13883), and upper air observations from Athens, GA (Station No. 13873).[16] DHEC has recently (March 2008) processed Columbia meteorological data for the period

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[15] U.S. EPA, *Users Guide for the AERMOD Terrain Preprocessor (AERMAP)*, EPA-454/B-03-003, Research Triangle Park, NC.

[16] South Carolina DHEC, *Air Quality Modeling Guidelines* (July 2001), Section 5.2.1.1.

of 2002-2006 and also made them available via the DHEC website.[17] Since Athens, GA ceased launching upper air soundings in August 1994, the upper air observations used in the modeling analysis were taken from the Greensboro, NC site (Station No. 13723). The height of the meteorological profile base (met station elevation above sea-level, used in computation of the potential temperature) is listed on the National Climatic Data Center (NCDC) website as 64.9 meters.[18] The 2002-2006 data were selected for this analysis in order to conduct modeling with the most recent, five-year period available and to incorporate recent changes to the land use parameterization within AERMET as detailed in Section 3.5.1.

3.4 Receptors

Emissions from the Pee Dee facility may be transported directly to water bodies in the assessment area, via dry and wet deposition. In addition, runoff within the watershed may also transport trace contaminants to the rivers.[19] Therefore, deposition to the entire Pee Dee River watershed was reviewed. To capture the overall mercury deposition impacts in the vicinity of the Pee Dee facility and also the watershed as a whole, an extensive array of receptors were used in the AERMOD analysis. A receptor grid with 1 km spacing was used to cover the entire Pee Dee River Basin, an area extending from 150 km north and west of the Pee Dee facility all the way to the Carolinas coastline (extending from roughly Georgetown, SC to near Wilmington, NC). The extents of the Pee Dee River Basin area were determined using digital mapping available from the USGS National Hydrography Dataset.[20] The ArcView Geographic Information System (GIS) software was used to create a polygon from the mapping data, which represented the entire watershed. That polygon was then used as an outer boundary in the creation of the AERMOD receptor grid described above. To check the accuracy of the mapping data, ArcView was used to isolate the portion of the watershed within South Carolina, and used as a comparison with the basin area reported on the SCDHEC website.[21] Figure 3-1 shows a plot of the modeled receptor points.

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[17] South Carolina DHEC Website, (URL: http://www.scdhec.net/eqc/baq/html/modeling.html)

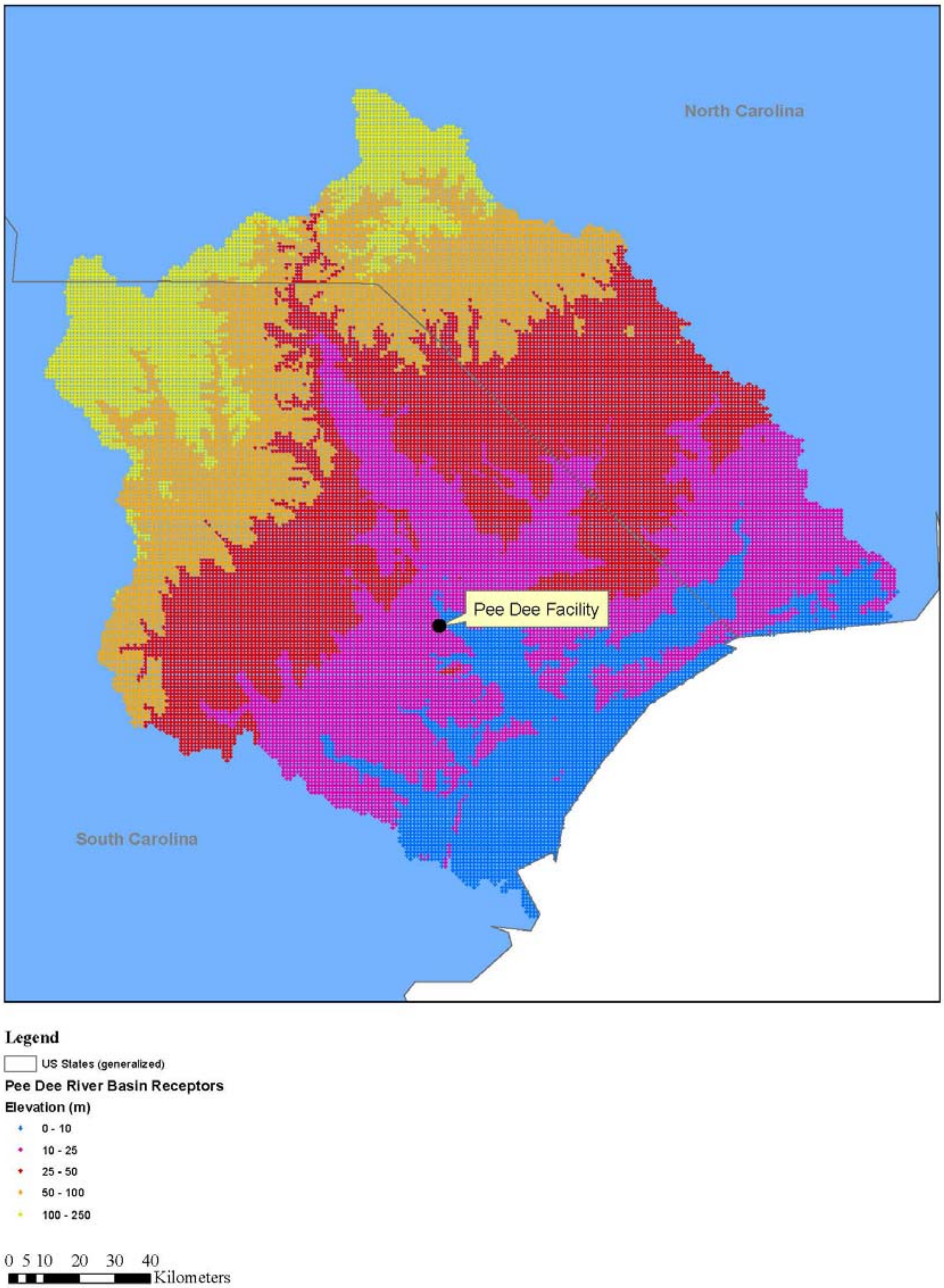
[18] Note that the DHEC website lists the base elevation as 245 feet (74.7 m). However, this appears to be the base elevation plus the anemometer height.

[19] Although it is less likely that runoff will transport materials that have been dry deposited to the river, dry deposition throughout the watershed area is also included.

[20] URL: http://nhd.usgs.gov/data.html

[21] URL: http://www.scdhec.net/environment/water/shed/pd_main.htm

FIGURE 3-1. RECEPTORS IN THE SCREENING LEVEL AERMOD DEPOSITION ANALYSIS



In addition to the full river basin analysis described above, a refined analysis was performed for those areas with relatively higher deposition impacts. Since the risk calculations use a deposition value that is averaged over the entire modeling domain, the use of the smaller receptor set helps maintain conservatism in the risk analysis. Based on comments received from USEPA[22], the refined receptor grid was defined based on 10-digit Hydrologic Unit Codes (HUC), which were developed by USGS to define smaller regions within large water basins. Based on results discussions with USEPA, a deposition threshold of 0.15 $\mu g/m^2/yr$ was used to define the primary area of interest[23]. Using that threshold and the HUC approach discussed in agency comments, any HUC which included at least 1 receptor with a modeled impact of 0.15 $\mu g/m^2/yr$, was included in this refined analysis. Receptors were created throughout each HUC, and within 50 km of the proposed Pee Dee facility at a spacing of 500 meters.

Figure 3-2 represents the Pee Dee watershed used in the screening analysis and the refined effective watershed, based on the affected HUCs, used in the refined analysis. Figure 3-3 illustrates the refined set of model receptors.

[22] Email from Rick Gillam (USEPA) to Heather Robbins (LPA Group) on August 22, 2008

[23] Risk Assessment meeting with USEPA, LPA Group, Santee Cooper and Trinity Consultants, July 24, 2008.

FIGURE 3-2. PEE DEE WATERSHED AND EFFECTIVE WATERSHED

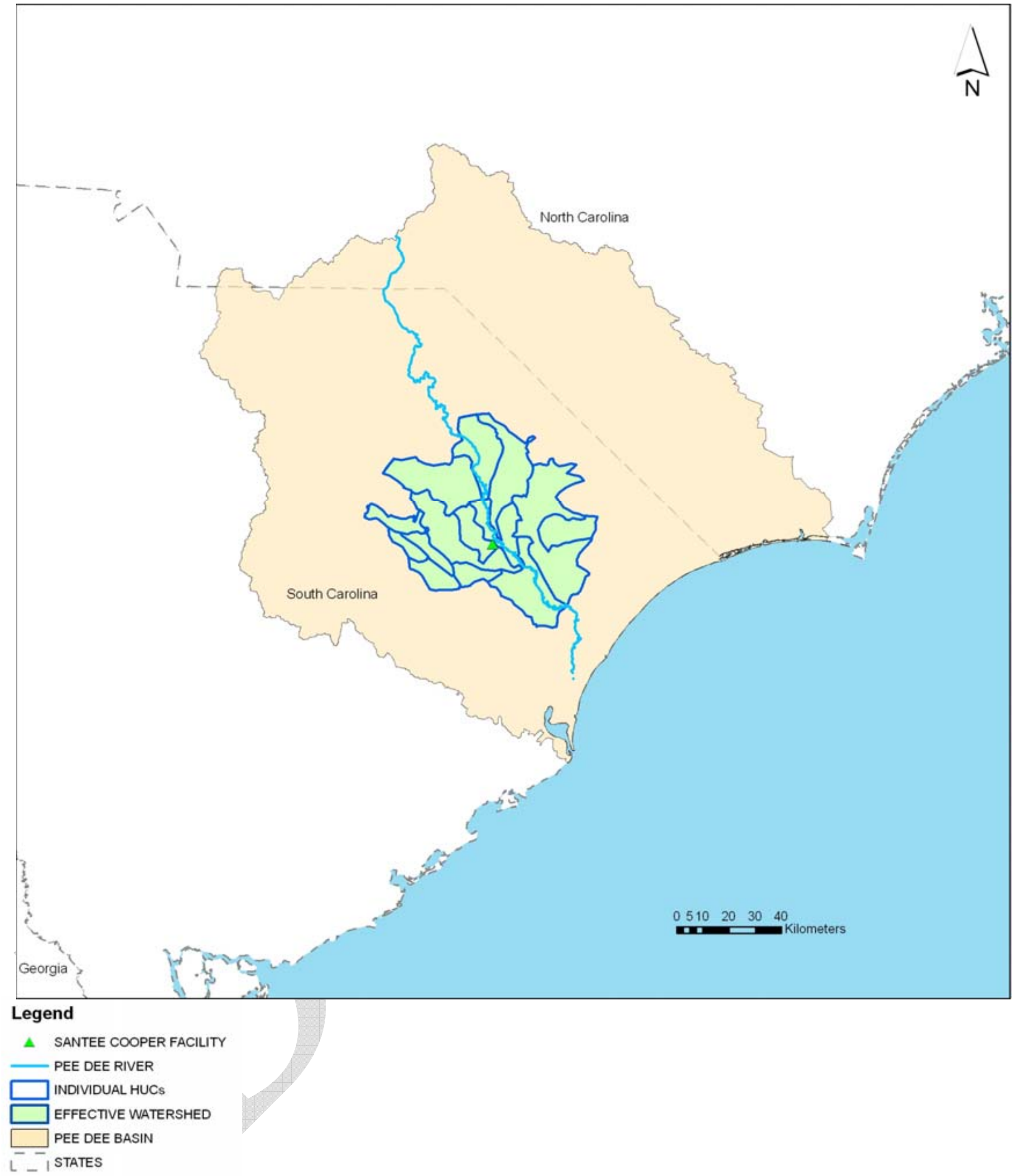
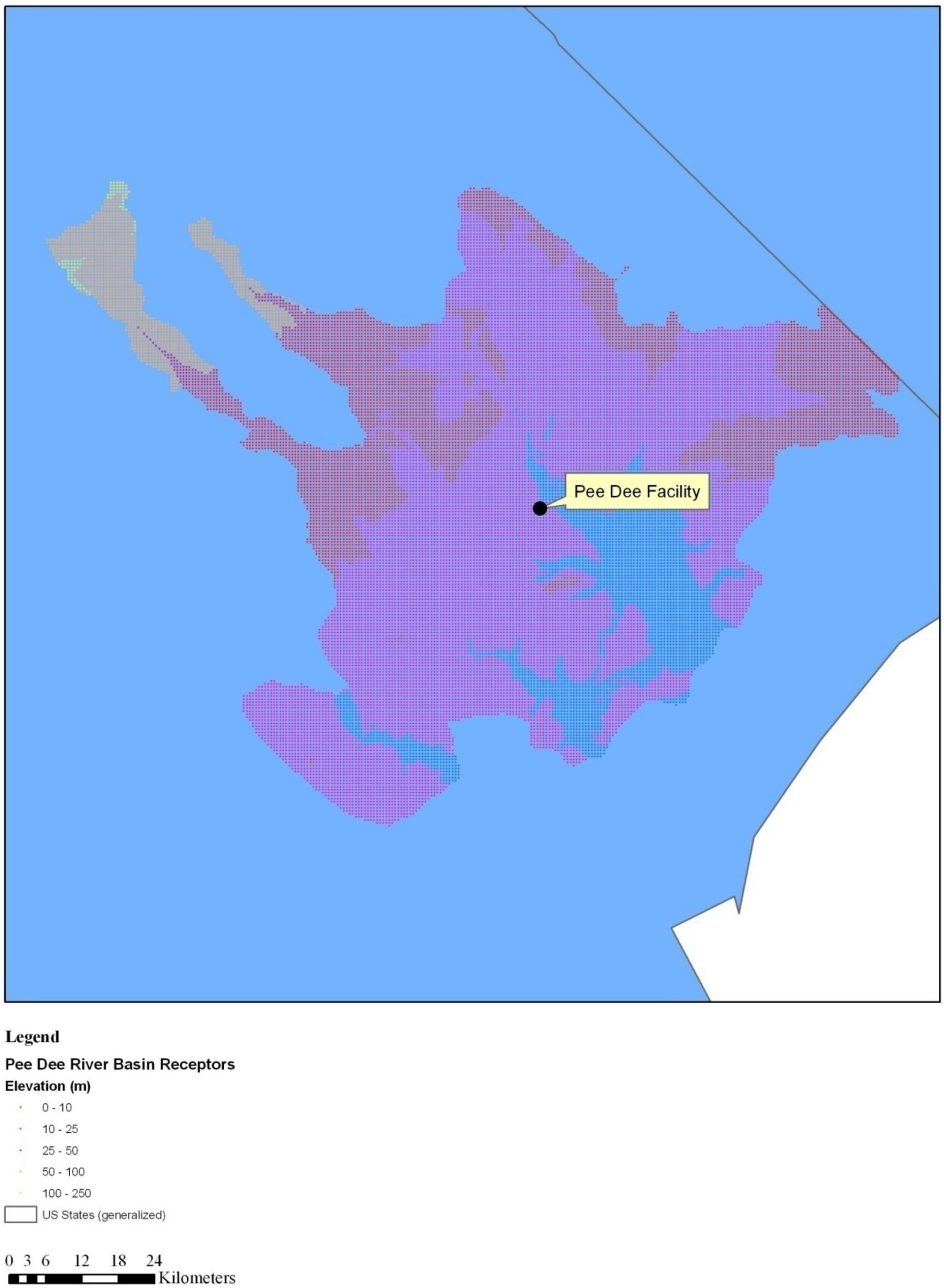


FIGURE 3-3. REFINED MODELING RECEPTOR SET



3.5 LAND USE ANALYSIS

3.5.1 AERMET LAND USE

AERMOD meteorological data inputs include land use specific parameters. When processing the datasets in the preprocessing program, AERMET, the user must supply values for the albedo, Bowen ratio, and surface roughness. Each of these values varies with differing landuse and has an effect on the meteorological data that are used in AERMOD (especially the surface roughness length). The US EPA has recently released the AERSURFACE program, which estimates surface characteristics based on the National Land Cover Database, 1992 version (NLCD92).[24] The associated AERSURFACE User's Guide details new guidance on how to assign surface characteristics based on the updated landuse data.[25] DHEC has recently updated the Columbia meteorological data to reflect the new AERSURFACE parameters and also the time period to 2002-2006.[26]

The new AERSURFACE guidance has made it more difficult to define land use representativeness, especially with regards to surface roughness which is the parameter to which AERMOD model concentrations are the most sensitive. The area immediately surrounding the airport meteorological data sites is typically comprised of grasses, concrete and other landuse types with low surface roughness values. For new industrial sites, the pre-construction landuse is often comprised of wooded areas, which have high surface roughness values. As such, the surface roughness comparison does not always show good agreement between airport and facility locations. The land will be cleared as part of early construction activities, so the post-construction landuse will be very similar to an airport location.

Given the differences in the surface roughness values, the mercury deposition analyses were performed using both the DHEC-provided meteorological data as well as the reprocessed data using the current Pee Dee landuse parameters. The Pee Dee landuse data yielded the highest deposition values, and as such, those model results were used in the risk analysis.

A detailed landuse comparison and discussion is included as Appendix C of this report.

3.5.2 DEPOSITION LAND USE

In addition to a review of land use for meteorological processing, the deposition algorithms require land use information. Within the model the user maps each 10-degree wind direction sector to a specific land use category.

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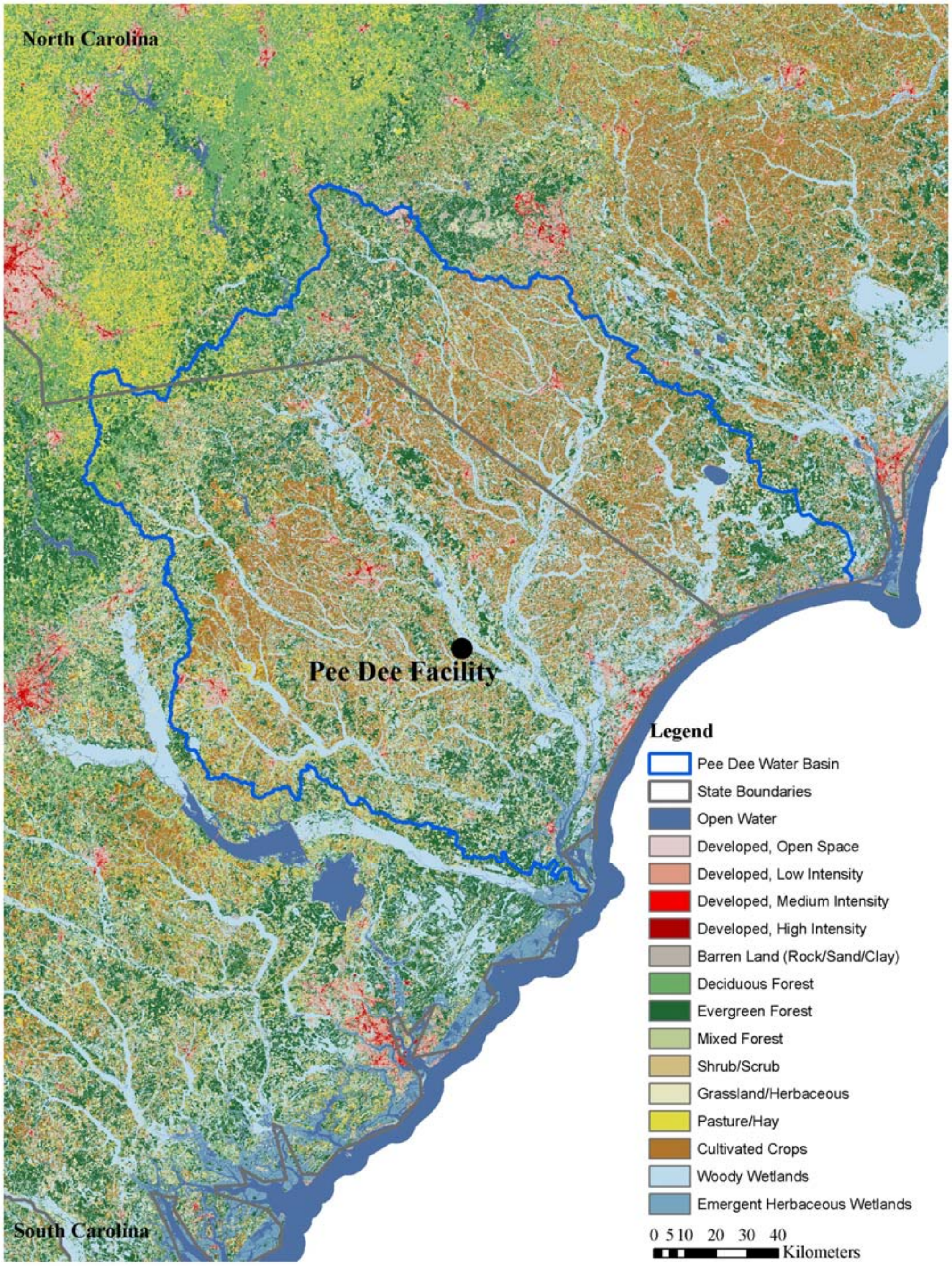
[24] URL: http://www.epa.gov/scram001/dispersion_related.htm#aersurface

[25] URL: http://www.epa.gov/scram001/7thconf/aermod/aersurface_userguide.pdf

[26] URL: http://www.scdhec.net/environment/baq/modeling.aspx

As shown in Figure 3-4, the landuse surrounding the Pee Dee facility is predominately a mix of forest and agricultural land. The area does not lend itself to creating discrete directional landuse sectors, and AERMOD does not allow mixed sectors to be entered. Santee Cooper performed analyses using agricultural and forested landuse to determine the maximum concentration and thus maintain conservatism. The forest landuse category yielded the highest concentrations and thus was selected for the final analysis.

FIGURE 3-4. LANDUSE SURROUNDING THE PEE DEE FACILITY



3.6 BUILDING DOWNWASH

The emission sources at the Pee Dee facility were evaluated in terms of their proximity to nearby structures. The purpose of this evaluation is to determine if stack discharges might become caught in the turbulent wakes of these structures leading to downwash of the plumes. Wind blowing around a building creates zones of turbulence that are greater than if the building were absent. The current version of the AERMOD dispersion model treats building wake effects following the algorithms originally developed for the ISC-PRIME model and maintained in the AERMOD model by Schulman and Scire.[27] This approach requires the modeler to input wind direction-specific building dimensions for structures located within 5*L* of a stack, where *L* is the lesser of the height or projected width of a nearby structure. Stacks taller than the structure height plus 1.5*L* are not subject to the effects of downwash in the AERMOD model.

For these modeling analyses, the direction-specific building dimensions used as input to the AERMOD model were calculated using the *BREEZE*®-AERMOD software, developed by Trinity. This software incorporates the algorithms of the U.S. EPA sanctioned Building Profile Input Program, PRIME version (BPIP PRIME), version 04274. BPIP PRIME is designed to incorporate the concepts and procedures expressed in the GEP Technical Support document, the Building Downwash Guidance document, and other related documents.[28]

The BPIP input, output and summary files from the analysis are included with the other electronic modeling files in Appendix D.

3.7 REPRESENTATION OF EMISSION SOURCES

3.7.1 COORDINATE SYSTEM

In all model input and output files, the locations of emission sources, structures, and receptors were represented in the Universal Transverse Mercator (UTM) coordinate system. The UTM grid divides the world into coordinates that are measured in north meters (measured from the equator) and east meters (measured from the central meridian of a particular zone, which is set at 500 km). The central location of the Pee Dee facility is approximately 639 km East and 3,755 km North in Zone 17 (NAD27).

Because the area of the Pee Dee facility where structures and emissions units are located is flat, a single base elevation was used in the model data files for all model objects. The base elevation for the facility is approximately 62 feet (19 meters) above mean sea level.

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[27] Earth Tech, Inc., *Addendum to the ISC3 User's Guide, The PRIME Plume Rise and Building Downwash Model*, Concord, MA.

[28] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, *Guidelines for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) (Revised)*, Research Triangle Park, North Carolina, EPA 450/4-80-023R, June 1985.

3.7.2 Source Types

The AERMOD dispersion model allows for emissions units to be represented as point, area, or volume sources. For point sources with unobstructed vertical releases, it is appropriate to use actual stack parameters (i.e., height, diameter, exhaust gas temperature, and gas exit velocity) in the modeling analyses. The Pee Dee boiler emission units were modeled as point sources using proposed stack parameters. Table 3-4 provides source parameters for the collocated boiler stacks.

Table 3-4. Source Parameters

Unit	Unit ID	Stack Diameter (m)	Stack Height (m)	Stack Velocity (m/s)	Temperature (K)
Main Boilers	B01-02	7.62	198.1	18.29	323.15

3.8 Mercury Deposition-Specific Model Settings

3.8.1 Gaseous Deposition Parameters

A number of physicochemical parameters are used by the AERMOD dispersion model in order to estimate both wet and dry gaseous deposition for vapor phase divalent and elemental mercury. These parameters include: diffusivity of mercury in air in cm^2/s (D_a), diffusivity of mercury in water in cm^2/s (D_w), Henry's law constant (H) in Pa-m^3/mol and the cuticular resistance (uptake by the lipid layer covering leaves) in s/cm.

The values selected for those parameters for both forms of gaseous mercury are provided in the Table 3-5 below.

Table 3-5. Summary of Gaseous Deposition Parameters for Mercury

Gaseous Deposition Parameters	Hg(II) - RGM	Hg(0) - Elemental
Diffusivity in Air (D_a), cm^2/s	0.06	0.07
Diffusivity in Water (D_w), cm^2/s	5.20E-06	3.00E-05
Cuticular Resistance, s/cm	1.00E+05	1.00E+05
Henry's Law Constant (H), Pa-m^3/mol	7.19E-05	1.50E+02

These parameters were selected based on a literature review of AERMOD supporting documents, EPA Human Health and Risk Assessment Protocol (HHRAP), and mercury risk assessment studies.[29,30,31]

[29] Wesley, M. L., P. V. Doskey, and J.D. Shannon , *Deposition Parameterizations for the Industrial Source Complex (ISC3)* June 2002.

The diffusivity in air, cuticular resistance, and Henry's law constant, for elemental mercury, were taken from the Argonne National Lab (ANL) report.[32] The ANL report provides these suggested values for use in AERMOD deposition algorithms. The ANL report is part of the model documentation for the AERMOD model, therefore it was considered to be the primary source document for the specific deposition parameters. The ANL report does not contain the diffusivity in water (D_w) for either divalent- or elemental vapor phase mercury species, therefore a secondary reference was also utilized to provide missing data. Specifically, missing parameters were selected from the USEPA HHRAP companion database**,** which includes a comprehensive database of chemical-specific parameter values developed by the EPA in 1998 and finalized in 2005.[33] Additionally, the Henry's law constant for divalent mercury was adopted from the HHRAP companion database, over the ANL report, primarily due to inconsistencies between the ANL report and other documents reviewed. The HHRAP value has been consistently used in the HHRAP companion database and the EPA's Mercury Study to Congress and other risk assessments studies and was therefore selected in lieu of the ANL value. [34, 35, 36]Furthermore, the use of the Henry's law constant value selected from the secondary reference results in higher or more conservative risk estimates.

In addition to the chemical-specific parameters described above, the user must also map each month of the year to a seasonal category. The seasonal categories are used to estimate foliage coverage, which is an important factor in deposition calculations. In AERMOD, the default seasons correspond to their calendar months. For example, winter is defined as the months from December to February, and spring is defined as the months from March to May. The default seasons were used for the gaseous deposition analyses with the following exceptions:

- May and September were considered summer months, since trees have full foliage by May and maintain that foliage through September in South Carolina.

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[30] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA530-R-05-006.

[31] U.S. EPA, *Mercury Study Report to Congress Volume III, Fate and Transport of Hg in the Environment*, December 1997. EPA452/R-97-005.

[32] Wesley, M. L., P. V. Doskey, and J.D. Shannon, *Deposition Parameterizations for the Industrial Source Complex (ISC3)* June 2002.

[33] HHRAP Companion Access Database, September 2005, EPA520-R-05-006 (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[34] Risk Management & Engineering Ltd., *Human Health and Ecological Screening Risk Assessment Report Revision No. 1*, August 2007, prepared for the Ash Grove Cement Company.

[35] Marsik, F. J., Keeler, G. K. *The Dry Deposition of Speciated Mercury to a Forest Ecosystem (GL00-002) and the Air-Surface Exchange of Speciated Mercury to Agricultural Crops and Soils (GL01-017),* August 2003, prepared for the Office of the Great Lakes.

[36] URS Corporation, *Draft Mercury Risk Assessment Report*, October 2006, prepared for the Associated Electric Cooperative Inc.

- Winter was characterized in the model as "late autumn or winter with no snow" since South Carolina does not experience any months with prolonged snow cover.

These seasonal assignments also correspond with those used by DHEC in the AERSURFACE analyses.

Default reactivity factors and leaf area index factors, as incorporated in the regulatory version of AERMOD were used for elemental and particulate mercury modeling. As recommended by the AERMOD User's Guide, the reactivity factor was changed to one for divalent mercury.[37]

3.8.2 Particulate Mercury Deposition Parameters

In order to consider particulate deposition in the AERMOD model, the user must input particle size information for the species of interest. AERMOD allows these data to be entered using one of two methods, Method 1 or Method 2. Method 1 is used in cases where the particle size distribution is well-understood. The user can input one or more particle size categories, each requiring the mean particle diameter, particle density, and mass fraction. Method 2 is used when the particle size distribution is not well-understood, or in cases where a significant portion of the particulate mass is in the $PM_{2.5}$ size spectra. Method 2 only requires the user to input a mean particle diameter and mass fraction for the $PM_{2.5}$ size category. In the case of particulate Hg, the size distribution is not well-known and thus Method 2 was used in AERMOD. A mean particle diameter of 0.4 microns, with a mass fraction of 0.8 (80%) for particles in the $PM_{2.5}$ size category was used per guidance in the ANL deposition report.[38]

3.9 Deposition Model Results

3.9.1 Predicted Mercury Deposition – Screening Level Analysis

Figures 3-5 through 3-8 present air dispersion modeling results, as predicted by the AERMOD model for elemental mercury, divalent mercury including vapor- and particle bound phases and all forms combined. The values shown represent the average over five years of meteorological data (2002-2006). As shown in the figures, divalent mercury constitutes the highest fraction of the impacts, due to its reactive and hygroscopic nature.

Air dispersion modeling results for annual concentration and dry and wet deposition for individual mercury species including elemental vapor, divalent vapor and divalent particle-bound were used as inputs to complete the screening level risk assessment, as described in Section 4.0.

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[37] U.S. EPA, *Addendum – User's Guide for the AMS/EPA Regulatory Model – AERMOD*, December 2006 EPA-454/B-03-001.

[38] Wesley, M. L., P. V. Doskey, and J.D. Shannon, *Deposition Parameterizations for the Industrial Source Complex (ISC3)* June 2002.

FIGURE 3-5. ANNUAL AVERAGE MODELED ELEMENTAL MERCURY DEPOSITION

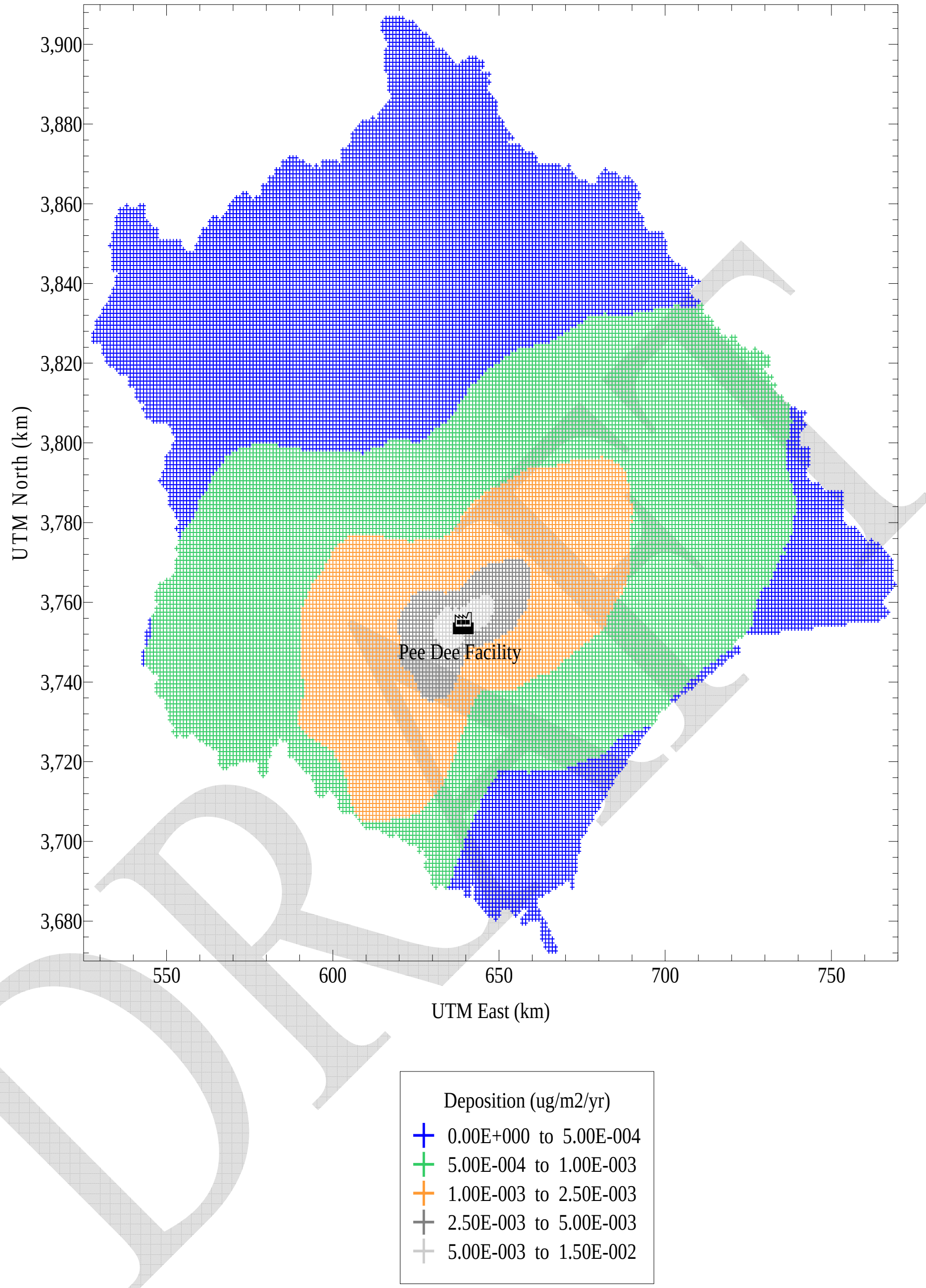


FIGURE 3-6. ANNUAL AVERAGE MODELED DIVALENT MERCURY VAPOR PHASE DEPOSITION

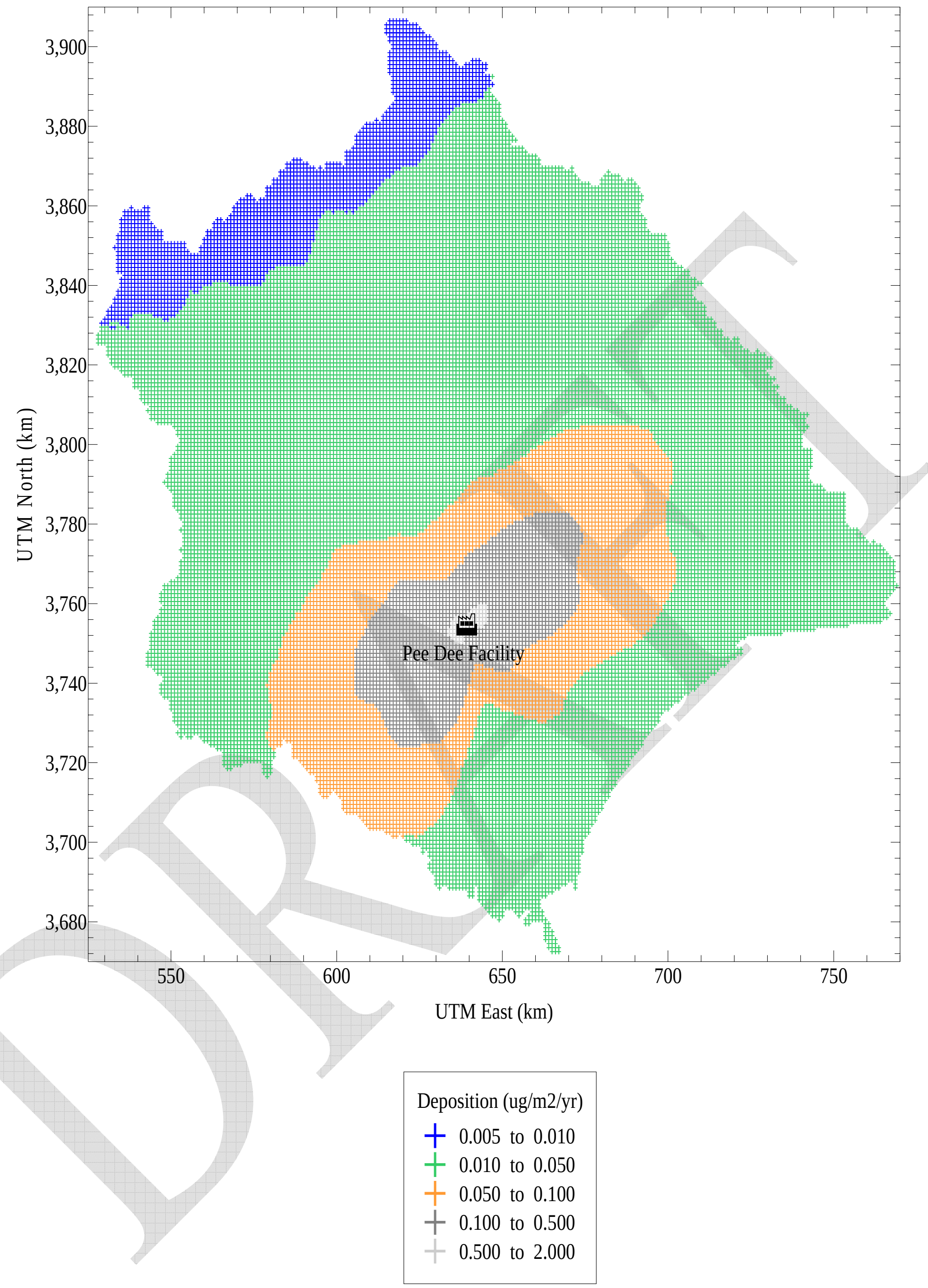


FIGURE 3-7. ANNUAL AVERAGE MODELED PARTICLE-BOUND PHASE MERCURY DEPOSITION

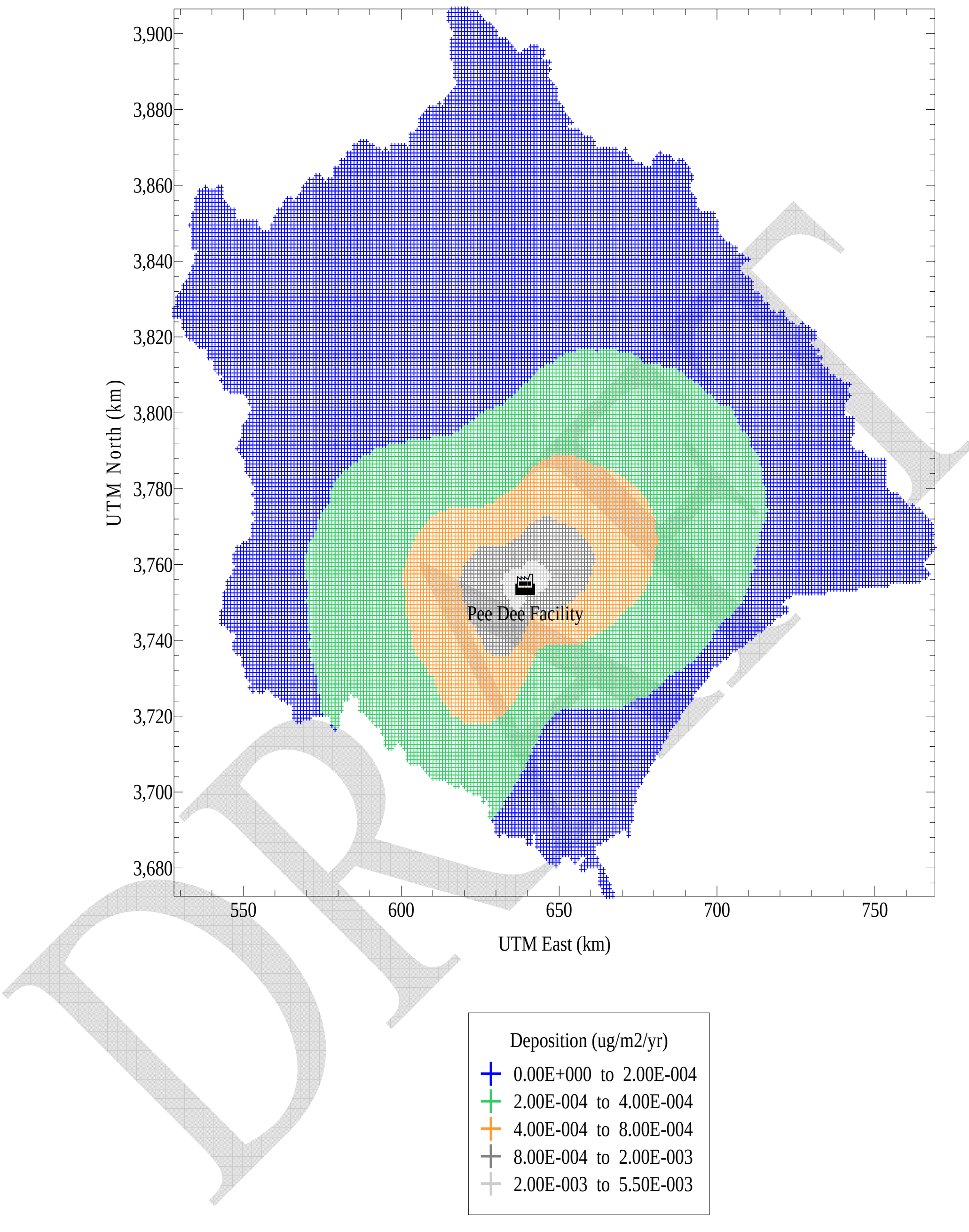
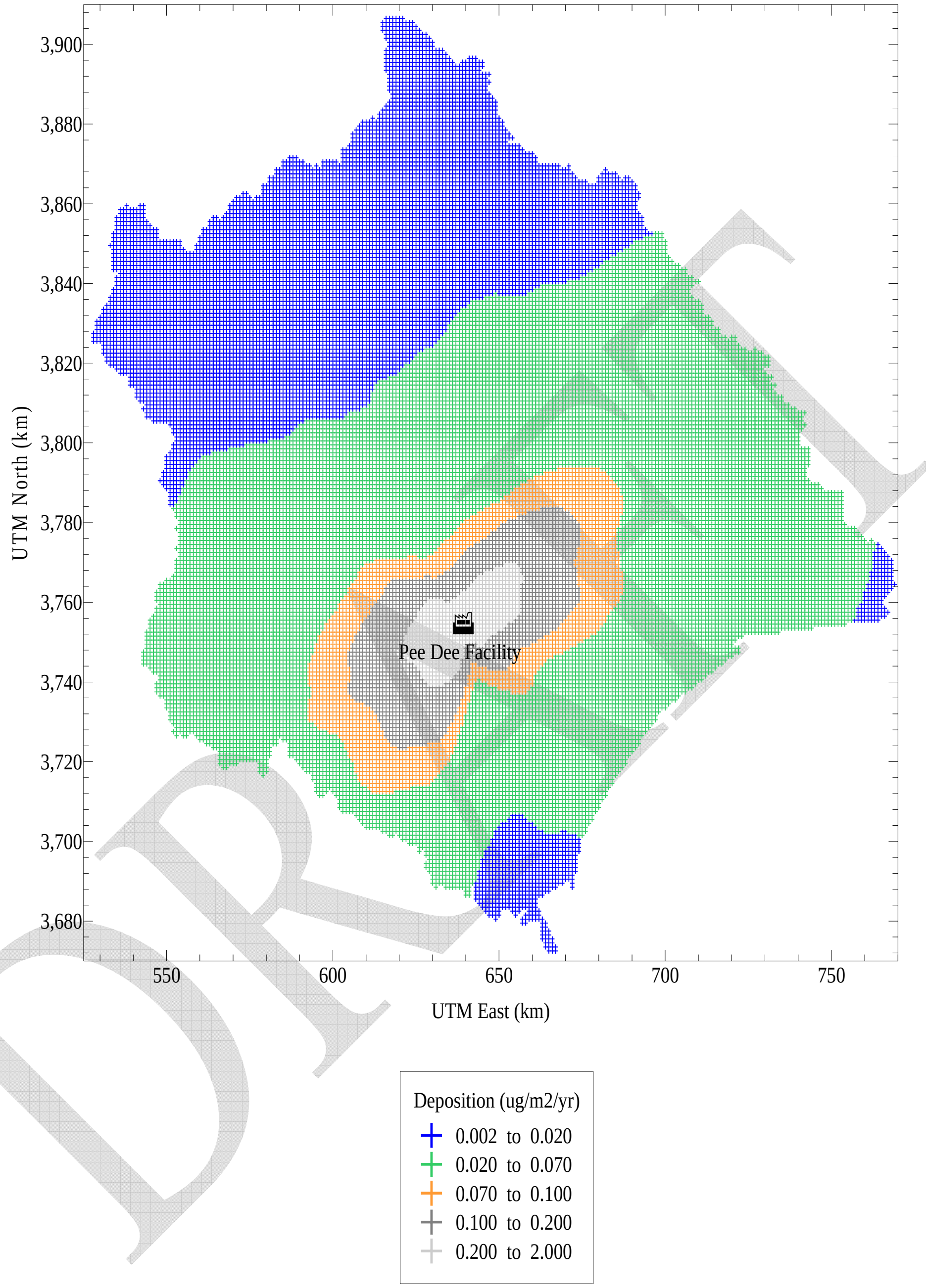


FIGURE 3-8. ANNUAL AVERAGE MODELED TOTAL MERCURY DEPOSITION



3.9.2 PREDICTED MERCURY DEPOSITION – REFINED ANALYSIS

Air dispersion modeling results generated to support the screening level and refined risk analysis differ only in the grid density (1 km vs 500 m) and coverage area or modeling domain. Figures 3-9 through 3-12 present air dispersion modeling results, as predicted by the

AERMOD model for elemental mercury, divalent mercury including vapor- and particle bound phases and all forms combined, over the refined set of model receptors. The values shown represent the average over five years of meteorological data (2002-2006). As shown in the figures, divalent mercury constitutes the highest fraction of the impacts, again due to its reactive and hygroscopic nature.

FIGURE 3-9. ANNUAL AVERAGE MODELED ELEMENTAL MERCURY DEPOSITION (REFINED GRID)

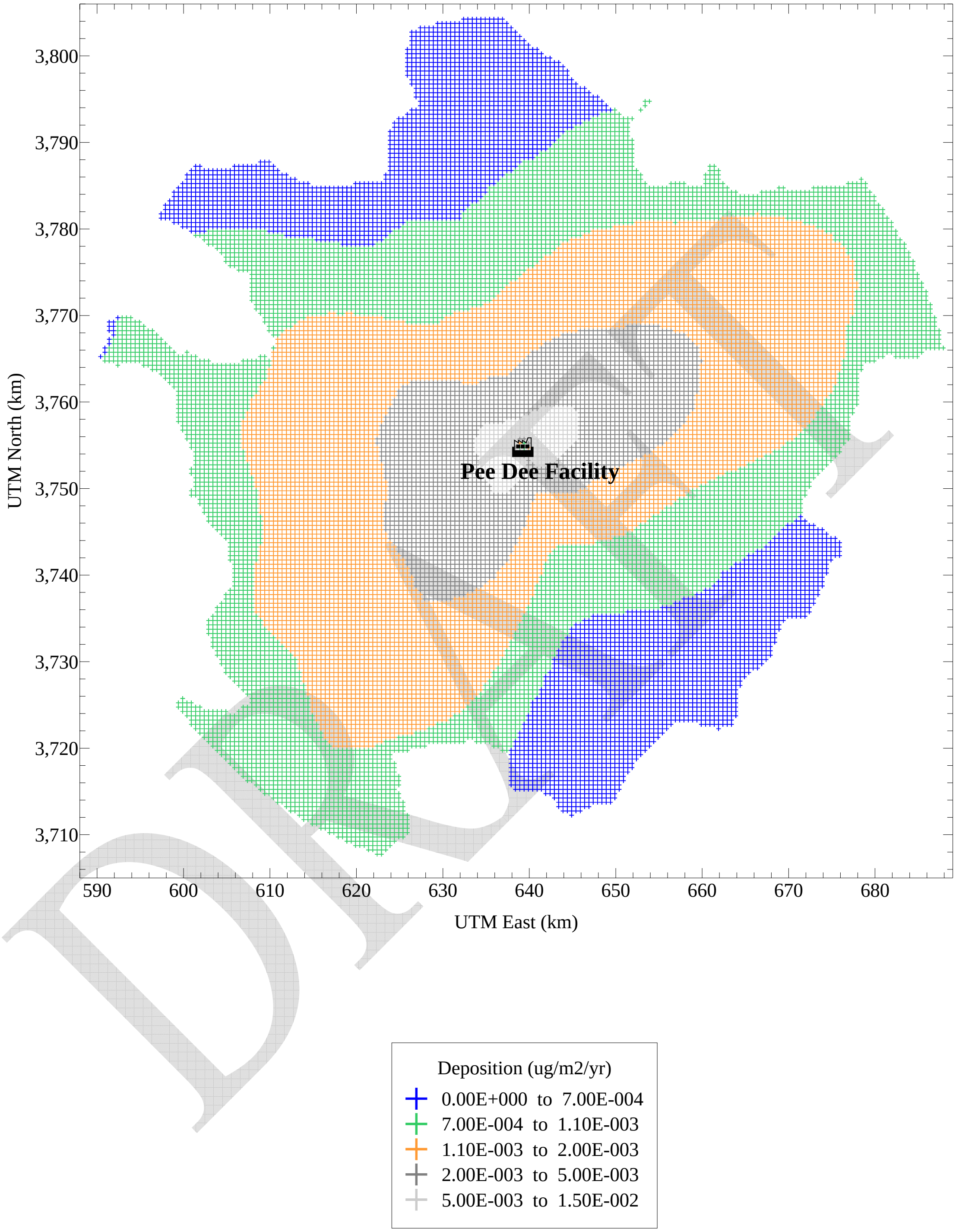


FIGURE 3-10. ANNUAL AVERAGE MODELED DIVALENT MERCURY VAPOR PHASE DEPOSITION (REFINED GRID)

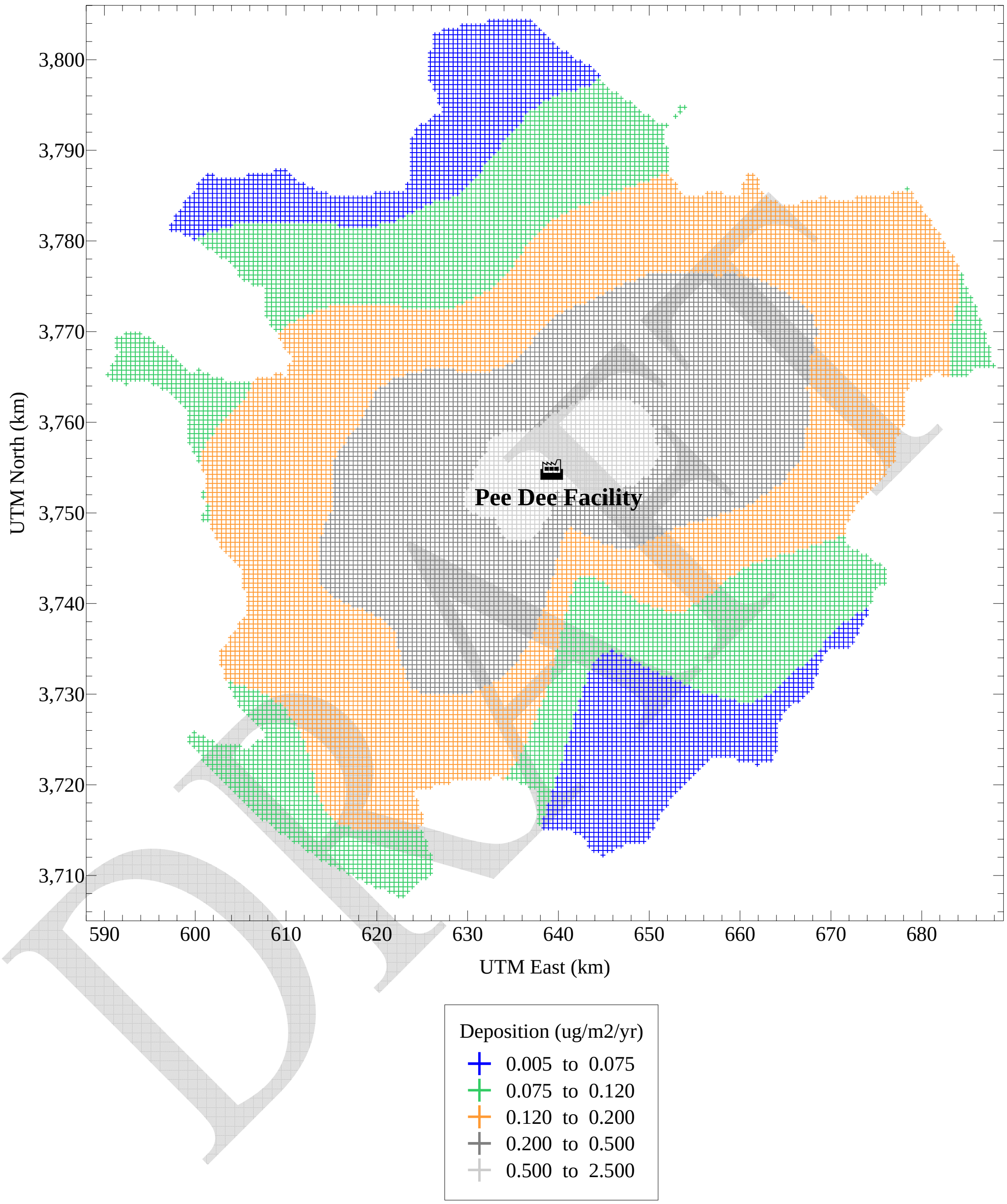


FIGURE 3-11. ANNUAL AVERAGE MODELED PARTICLE-BOUND PHASE MERCURY DEPOSITION (REFINED GRID)

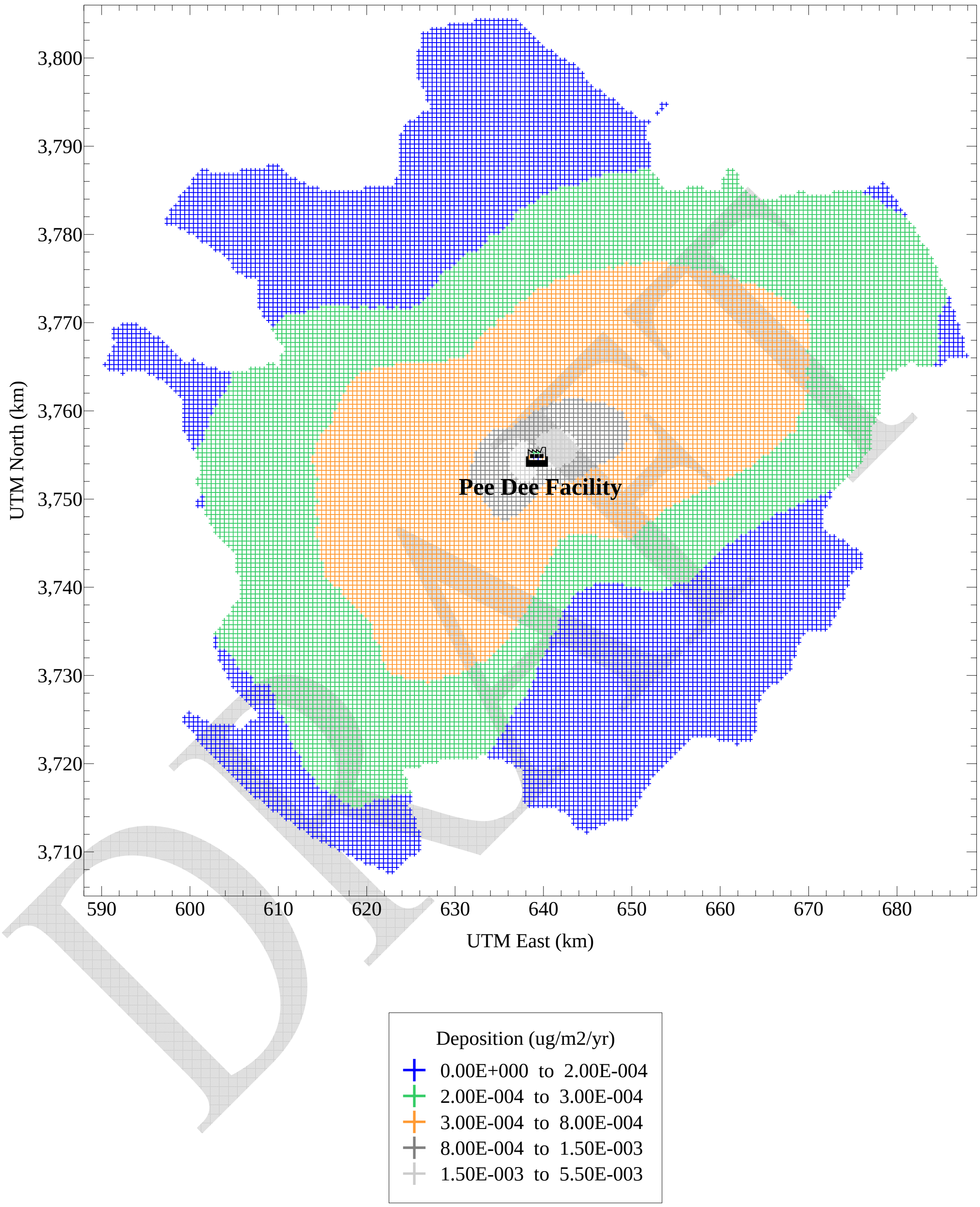
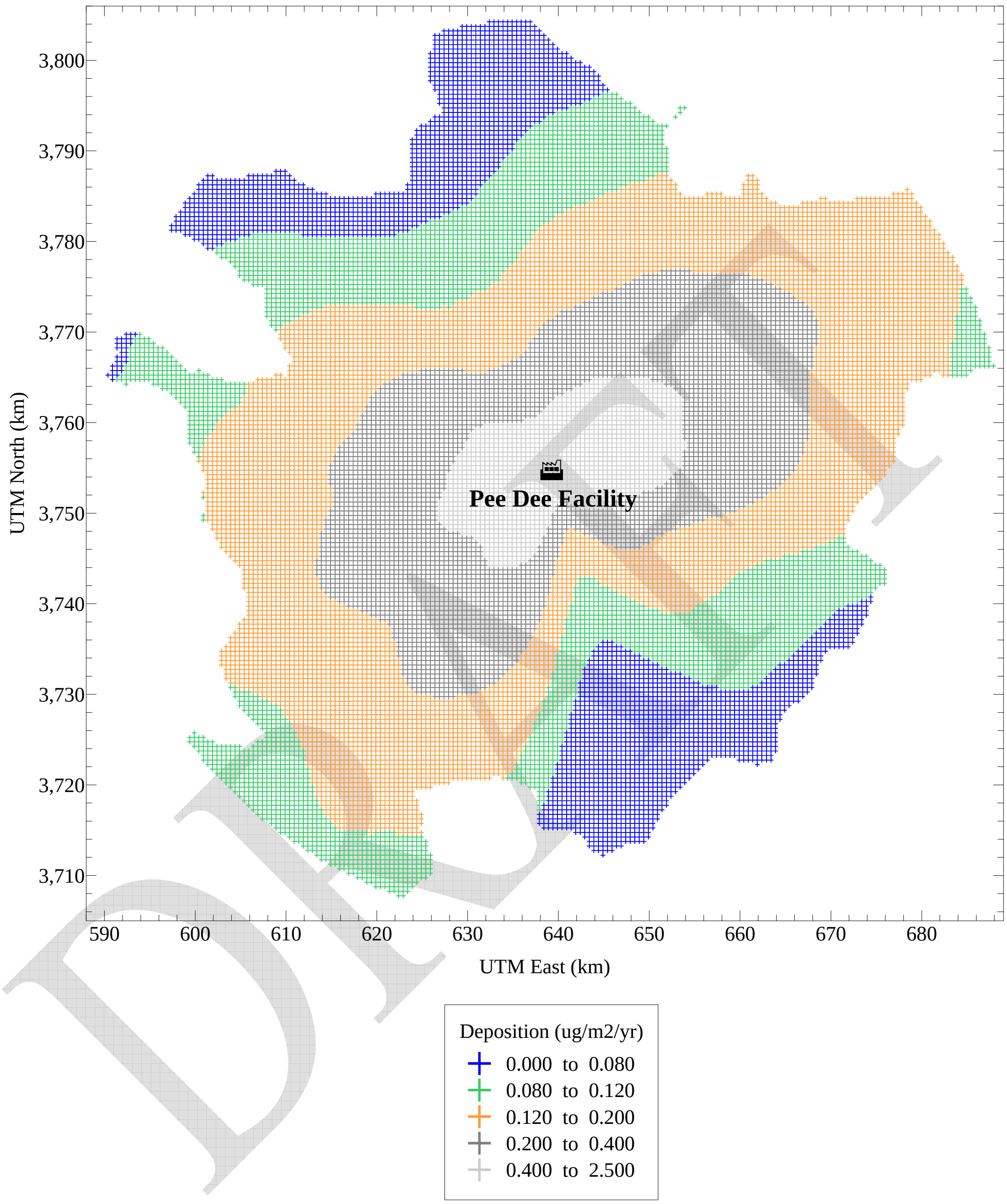


FIGURE 3-12. ANNUAL AVERAGE MODELED TOTAL MERCURY DEPOSITION (REFINED GRID)



The air dispersion modeling results, presented graphically above, were then used as inputs to the estimating media and exposure equations, to calculate potential health risks, as described in the following sections. The AERMOD input and output files described in this section are provided in Appendix D.

4. ESTIMATING MEDIA CONCENTRATIONS, EXPOSURE, AND RISK

The majority of mercury in soil, water and sediment is in the form of inorganic mercury salts or organic forms of mercury. Of particular interest from a human health risk perspective is methylmercury which is the form that most efficiently bio-accumulates in the aquatic food web including fish tissue. Methylation of mercury occurs through biotic and abiotic processes and is not associated with combustion source emissions. Not all mercury entering the environment methylates. In addition demethlylization also occurs and further reduces the amount of available methylmercury on a localized level. Mercury enters aquatic systems primarily as divalent (i.e., mercuric chloride) through direct deposition to the surface water body or diffusion, and can also be transported to the water body via runoff from the watershed. As discussed in Section 3.0, air dispersion modeling was performed to account for the transport, diffusion, and deposition of mercury in the environment once emissions leave the stack. Results of the air dispersion modeling analysis were used as inputs to the estimating media and exposure equations as provided in HHRAP Appendix B and C respectively, to calculate potential human health risks.

As mentioned earlier in Section 1 the risk assessment analysis was implemented in two stages. Stage one included completion of a screening-level air and risk modeling analysis. Stage two was conducted as a refinement to the screening level analysis and specifically intended to reduce uncertainty by more closely following the USEPA HHRAP guidance document. To complete the first phase, a basic screening-level analysis was created, using MS Excel spreadsheets, to evaluate risk using a simplified implementation of the HHRAP equations and methodologies. The screening-level model was then further refined by fully implementing the HHRAP guidance document including methodologies, equations, and chemical-specific fate and transport parameters; with a specific focus on the incorporation of additional site specific data. The refined analysis was also completed using a MS Excel spreadsheet model. However, for the refined risk analysis, spreadsheets were significantly expanded to include complete equations for the selected exposure scenarios as provided in Appendix B and C of the HHRAP. Appendix B and C describe the equations, and associated fate and transport parameters for estimating chemical- and media-specific concentrations which are subsequently used to evaluate selected exposure scenarios. Appendix B also specifically includes equations for modeling phase allocation and speciation of mercury concentrations in media, which has been the focus of this report. Appendix C provides the equations for quantifying exposure pathway-specific risk estimates. As recommended in the HHRAP, supporting spreadsheet calculations are fully referenced and designed to be transparent by presenting individual equations, equation input parameters, and results for all calculations. Additionally, to ensure accuracy and compliance with the HHRAP, spreadsheets were validated by comparing against results generated using the USEPA Risk Management and Analysis Platform (RISK-MAP v2.3)[39] software model specifically designed to implement the HHRAP guidance.

[39] U.S. EPA, *User's Manual for Risk Management and Analysis Platform (Risk-MAP)*, Third edition, February 2007.

The results of the risk assessment process provide numerical estimates of potential human health risks. In order to evaluate potential human health risks, exposure estimates are compared with target health levels established by government and public health agencies. In the case of mercury and mercury compounds, hazard, or non-cancer health effects are used to evaluate potential human health risks. Hazard is defined as the potential for developing *noncancer* health effects as a result of exposure to COPCs. The calculated hazard value is compared as a ratio with a standard exposure level to ensure exposure to COPCs poses no appreciable likelihood of adverse health effects to potential human receptors, including special populations.

Section 4.1 describes the screening level risk analysis. Section 4.2 describes the refined level risk analysis. Each section includes subsections that further detail the estimating media concentrations equations, exposure equations and risk characterization process.

4.1 SCREENING-LEVEL RISK ANALYSIS

The screening-level risk analysis was developed as a preliminary estimate of the risk associated with mercury emissions from the Pee Dee facility. The screening-level risk assessment used a simplified form of equations and methodologies presented in the HHRAP to provide conservative estimates of potential human health impacts. As a result of these simplifications and to streamline the risk assessment process, methylmercury was the only COPC evaluated in the screening level analysis. Detailed calculations of the screening-level risk analysis are provided in Appendix B of this report. Key assumptions and important aspects of the screening level risk assessment include:

- Fisher Adult and Child exposure scenarios were considered to represent potential exposure using fish consumption rates representative of the general population.
- Consideration of subsistence fishing scenarios was not evaluated.
- Consideration of loss to the mercury global mercury cycle was not evaluated.
- All deposition of total mercury within the Pee Dee River watershed was assumed to enter the water body and used as the basis for calculating surface water concentration.
- Mercury deposition is assumed to be the only loading mechanism to the water body.
- No fate and transport losses (e.g., volatilization) were considered.
- Fish ingestion was the only exposure pathway considered in this assessment.
- The risk estimates are intended to represent potential exposure across the entire Pee Dee watershed.
- Methylmercury was the only COPC considered in this evaluation.

4.1.1 ESTIMATING MEDIA CONCENTRATIONS

Based on the AERMOD-predicted deposition values as described in Section 3, the concentration of mercury in selected surface water bodies was estimated. Surface water calculations were then used to estimate the fish concentrations as follows.

4.1.1.1 ESTIMATING MERCURY CONCENTRATION IN SURFACE WATER

Mercury concentration in surface water is affected by the various loading mechanisms which include: direct deposition, direct diffusion of vapor phase mercury, runoff from impervious and pervious surfaces, and internal transformation of compound chemically or biologically as outlined in Equation 1.[40]

$$L_T = L_{DEP} + L_{dif} + L_{RI} + L_R + L_E + L_I \tag{1}$$

Where,
L_T = Total load to water body (kg/yr).
L_{DEP} = Deposition to water (kg/yr).
L_{dif} = Diffusion to water (kg/yr).
L_{RI} = Runoff from impervious surfaces (kg/yr).
L_R = Runoff from pervious surfaces (kg/yr).
L_E = load from soil erosion (kg/yr).
L_I = Load from internal transfer (kg/yr).

It was assumed that the total mercury loading to the water body will be via direct deposition. To ensure conservative estimates, all mercury deposited to the watershed is assumed to enter the surface water body. The deposition loading is calculated as per equation 2.[41]

$$L_T = L_{DEP} = SDR \times A_T \tag{2}$$

Where,

SDR = Surface Deposition Rate of total mercury obtained from AERMOD Modeling Results, µg/m^2/yr.
A_T = Area of Pee Dee watershed region, km^2.[42]

Based on the AERMOD modeling, SDR associated with mercury emissions from the Pee Dee facility to the watershed were modeled to be 4.4E-02 µg/m^2/yr. The total area of the Pee Dee watershed is 30,166 km^2. Total loading to the surface water body due to emissions from Pee Dee facility is then calculated to be 1.33 kg/yr.

Again to ensure a high level of conservatism, the dissolved phase mercury concentration (C_{dw}) is considered to be equal to the total mercury water concentration (C_{wtot}) which is calculated based on equation 3.[43]

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[40] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities,* September 2005, EPA 530-R-05-006, Chapter 5, Section 5.7.1, Equation 5-28, p. 5-63.

[41] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities,* September 2005, EPA 530-R-05-006, Chapter 5, Section 5.7.1.1, Equation 5-29, p. 5-64.

[42] The Pee Dee River water basin area was determined using digital mapping available from the USGS National Hydrography Dataset (URL: http://nhd.usgs.gov/data.html).

$$C_{dw}(or\ C_{wtot}) = \frac{L_T}{Vf_x \times f_{wc} + k_{wt} \times A_w \times (d_{wc} + d_{bs})} \tag{3}$$

Where,
L_T = Total mercury load to the water body, kg/yr.
Vf_x = Average volumetric flow rate through water body (m^3/yr).
V_{Dis}= Average volumetric flow rate of proposed facility wastewater discharges (m^3/yr)
f_{wc} = Fraction of total water body mercury concentration in the water column (unitless).
k_w = Overall total water body mercury dissipation rate constant (yr^{-1}).
A_w = Water body surface area (m^2).
d_{wc}= Depth of water column (m).
d_{bs} = Depth of upper benthic sediment layer (m).

The average volumetric flow rate through the Pee Dee River watershed is calculated as a function of the total watershed area multiplied by the reported annual precipitation for the watershed (based on 30 years of weather data).[44] It was assumed for the screening level risk assessment that all the mercury in the water body is present in the water column (f_{wc} = 1). For conservative estimates, it was assumed that there is no dissipation of mercury from the surface water (k_{wt} = 0). Equation 3 reduces to Equation 4 once the above mentioned assumptions are applied. The dissolved mercury surface water concentration is calculated using equation 4.

$$C_{dw} = \frac{L_T}{Vf_x} \tag{4}$$

Mercury in the water column is almost exclusively in the dissolved phase and is predominantly in the divalent mercury form. Per the HHRAP, methylmercury concentrations are first calculated using the fate and transport parameters for mercuric chloride and then apportioned into two forms based on an 85 percent divalent and 15 percent methylmercury speciation split in the water body[45]. As a point of comparison, a USGS study on mercury contamination has noted that the average methylmercury concentration ratio compared to the total mercury concentration was observed to be 0.12 (or 12%) for the Edisto River in the Santee basin and coastal drainage areas.[46] To remain conservative, the HHRAP recommended speciation split of 85% divalent and 15% methylmercury was applied in both the screening and refined risk analysis.

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[43] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities,* September 2005, EPA 530-R-05-006, Chapter 5, Section 5.7.4, Equation 5-35, p. 5-71.

[44] Monthly Stations Normals of Temperature, Precipitation and Heating and Cooling Degree Days (1971-2000) for South Carolina by National Oceanic and Atmospheric Administration (February 2002), the Florence RGNL AP Site was chosen (closest to Pee Dee facility).

[45] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities,* September 2005, EPA 530-R-05-006, Chapter 2, Section 2.3.5.3, p. 2- 52.

[46] USGS, *Contamination of Hydrologic Systems and Related Ecosystems, Water-Resources Investigation Report 99-4018B*, March 1999, Section B, p .147.

4.1.1.2 ESTIMATING METHYLMERCURY CONCENTRATION IN FISH

The bio-accumulation factor (BAF) for methylmercury is defined as the ratio of the concentration of methylmercury in fish to the dissolved methylmercury concentration in water as outlined in Equation 5.[47] The HHRAP recommends using a BAF for estimating mercury concentrations in fish.[48]

$$BAF_{fish_{(MeHg)}} = \frac{C_{fish_{(MeHg)}}}{C_{dw_{(MeHg)}}} \tag{5}$$

The BAF used in this study was based on the tropic level 4 fish average (50th percentile) draft national BAF used to develop the EPA methylmercury water quality criterion.[49] EPA estimated the draft national BAFs based on field data collected from across the United States and values reported in published literature. Further, EPA notes that the draft national methylmercury BAFs sufficiently represent bio-accumulation and may be used for developing fish tissue-based methylmercury water quality criterion in a state's or authorized tribe's water quality standards (in the absence of any other site-specific bioaccumulation data). The referenced value was used since site-specific BAF data for methylmercury are not available.

Table 4-1 outlines the estimated methylmercury concentration in fish (attributable to Pee Dee facility operations) and provides a comparison with the US EPA Methylmercury criterion and fish tissue levels for the Little Pee Dee River.

[47] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix B, Table B-4-27, p. B-270.

[48] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix A, Section A2-2.13.4, p. A-28.

[49] U.S. EPA, *Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion*, August 2006, EPA 823-B-04-001, Table 1, Section 3.1.3.1.3, p. 21 (URL: http://www.epa.gov/waterscience/criteria/methylmercury/guidance-draft.html).

TABLE 4-1 SUMMARY OF METHYLMERCURY CONCENTRATIONS - SCREENING

Type of Concentration	Value (mg methlymercury / kg fish tissue)
Total concentration of methylmercury in Fish due to emissions from Pee Dee Facility	0.02
US EPA Methlymercury water criterion†	0.30
Median concentration of methylmercury in fish for Great Pee Dee River*	0.89
Highest concentration of methylmercury in fish for Great Pee Dee River*	7.00

† Fish Tissue Residue Criterion (TRC) as specified in p. 14, Sec 3.1.2.2 (Chapter 3), Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

* Mercury concentration in fish selected from the USEPA fish advisory database for the Little Pee Dee River. Little Pee Dee River tissue reports were selected based on its proximity of the river to the facility's location. (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on)

4.1.2 QUANTIFYING AND ESTIMATING EXPOSURE

As discussed in Section 2.3, exposure scenarios are intended to define the combination of exposure pathways to which a human receptor may be exposed and form the numerical basis for estimating the type and magnitude of human exposure to COPCs. Based on consideration of current and reasonable potential future human exposure activities in the assessment area (i.e., area surrounding the facility) and based on the knowledge that U.S. EPA considers the fish ingestion pathway the primary (i.e., 99.9%) route of exposure in humans,[50] the Fisher Adult and Fisher Child scenarios were selected as the basis for estimating potential human health impacts.

The factors used to estimate exposure to methylmercury from ingestion of fish include the consumption rate, methylmercury concentration in the fish and the fraction of fish in the diet that is contaminated The intake of methylmercury from the ingestion of fish is calculated based on equation 6. The intake rates for the Fisher Adult and Fisher Child exposure scenarios are summarized in Table 4-2.

$$I_{fish_{(MeHg)}} = C_{fish_{(MeHg)}} \times CR_{fish} \times F_{fish} \qquad (6)$$

Where,
CR_{fish} = Consumption Rate of Fish, kg/kg-day body weight.
F_{fish} = Fraction of the fish contaminated, assumed 1 (or 100%) for conservative estimates.

[50] U.S. EPA, *Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion*, August 2006, EPA 823-B-04-001, Section 3.2.1.1, p. 27 (URL: http://www.epa.gov/waterscience/criteria/methylmercury/guidance-draft.html).

The consumption rates for the Fisher Adult and Child exposure scenarios were calculated using the total fish consumption data from US EPA Exposure Factors Handbook.[51,52]

TABLE 4-2 SUMMARY OF METHYLMERCURY DAILY INTAKE FOR FISHER ADULT AND FISHER CHILD SCENARIOS – SCREENING

Parameter	Value		Units
	Fisher Adult	Fisher Child	
Daily Intake of Methylmercury from Fish (due to the impact of emissions from Pee Dee Facility)	3.37E-06	6.41E-06	mg/kg-day
Daily Intake of Methylmercury from Fish (due to median background mercury concentration)†	1.93E-04	3.68E-04	mg/kg-day
Daily Intake of Methylmercury from Fish (due to highest background mercury concentration)†	1.52E-03	2.89E-03	mg/kg-day

† These intake rates are based on the median, highest fish concentration in the USEPA fish advisory database for the Little Pee Dee River (Refer to Table 4-1)

4.1.3 CHARACTERIZING RISK AND HAZARD

Risk and hazard characterization form the final step in the risk evaluation process and provide quantitative estimates for evaluating cancer risks and non-cancer hazards. The evaluation of cancer risk is used to estimate the probability that a human receptor will develop cancer as a result of exposure to carcinogenic chemicals. While cancer risks are an important metric in the risk assessment process, sufficient data are not available to quantify the carcinogenic effects of mercury. Additionally, health effects associated with exposure to mercury exhibit a threshold response and are therefore more appropriately evaluated by calculating a hazard quotient. The hazard quotient for a particular COPC is determined by comparing the estimated exposure dose to a chemical-specific reference dose (RfD). The HHRAP defines a reference dose (RfD) as a daily oral intake that is estimated to pose no appreciable risk of adverse health effects, even to sensitive populations, over a 70-year lifetime. As discussed throughout this document, exposure to methylmercury is from the fish ingestion exposure pathway. Therefore the hazard quotient ($HQ_{fish\text{-}ingestion}$) was calculated as outlined in Equation 7.[53]

$$HQ_{fish-ingestion} = \frac{I_{fish_{(MeHg)}} \times ED \times EF}{RfD \times AT \times 365} \qquad (7)$$

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[51] Total Fish Consumption for the South Atlantic Region (Table 10-1, Appendix 10A, Exposure Factors Handbook by U.S. EPA, August 1997) for an adult (15.2 g/adult) with an average body weight of 70 kg (Table C-1-5, Appendix C, HHRAP by U.S. EPA, September 2005).

[52] Mean Fish Consumption for the Age Group of 0-9 years (Table 10-2, Appendix 10A, Exposure Factors Handbook by U.S. EPA, August 1997) for a child (6.2 g/child) with an average body weight of 15 kg (Table C-1-5, Appendix C, HHRAP by U.S. EPA, September 2005).

[53] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities,* September 2005, EPA 530-R-05-006, Appendix C, Table C-1-8, p. C-26.

Where,
ED = Exposure Duration (yrs).
AT = Averaging Time (yrs).
EF = Exposure Frequency (days/yr).
RfD = Reference Dose for methylmercury (mg/kg-day).

Table 4-3 summarizes the parameters used to estimate the HQ for the Fisher Adult and Fisher Child scenario.

TABLE 4-3 SUMMARY OF EXPOSURE PARAMETERS FOR FISHER ADULT AND CHILD SCENARIOS – SCREENING

Parameter	Value		Units
	Fisher Adult	Fisher Child	
Reference Dose (Oral / Ingestion)†	1.00E-04	1.00E-04	mg/kg-day
Exposure Duration*	30	6	yrs
Averaging Time*	30	6	yrs
Exposure Frequency*	350	350	days/yr

† HHRAP Companion Access Database for methylmercury (URL:**http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb**)

* Based on the equation outlined in Table C-1-8 (pp. C-26 and C-27, Appendix C), HHRAP by USEPA, September 2005

Results of the screening level analysis are provided in Table 4-4. In order to evaluate potential human health risks, estimated HQs are compared with agency defined target levels. If the calculated HQ is less than the HQ target level, adverse health effects are considered unlikely and therefore protective of human health. For purposes of this risk assessment, an HQ target level of 1.0 was used. As shown in Table 4-4, the hazard quotient associated with mercury emissions from the Pee Dee facility is significantly lower than the HQ target level of 1.0 for the Fisher Adult and Fisher Child exposure scenarios. As such, there is confidence in the conclusion that no adverse health effects are expected from exposure to emissions attributable to the operation of the proposed Pee Dee facility.

TABLE 4-4 SUMMARY OF HAZARD QUOTIENTS FOR FISHER ADULT AND FISHER CHILD SCENARIOS – SCREENING

Parameter	Value		Hazard Quotient less than 1	
	Fisher Adult	Fisher Child	Fisher Adult	Fisher Child
Impact due to Emissions from Pee Dee Facility Hazard Quotient (Fish Ingestion)	0.03	0.06	**YES**	**YES**
Impact due to Median Background Concentration Hazard Quotient[1] (Fish Ingestion, Background Concentration)	1.9	3.5	**NO**	**NO**
Impact due to Highest Background Concentration Hazard Quotient[1] (Fish Ingestion, Background Concentration)	14.6	27.7	**NO**	**NO**
Pee Dee Emissions as % contribution to cumulative HQ				
Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	**1.71%**	**1.71%**	-	-
Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	**0.22%**	**0.22%**	-	-

[1]This Hazard Quotients are calculated based on the ingestion rate of the fish with median, highest methylmercury concentration in the Little Pee Dee River. (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on)

In addition to results based on exposure to mercury emission from the Pee Dee facility, consideration of mercury background concentrations was also included in the screening level analysis. This consideration was included to provide a frame of reference for understanding the potential impacts of Pee Dee Facility operations in comparison with background mercury concentrations and to further support the risk communications process.

While background methylmercury concentrations result in a HQ greater than 1.0, contributions from Pee Dee Facility operations result in an insignificant incremental increase in the overall cumulative HQ. In the case of background contributions to the overall cumulative HQ, it should further be noted that that an HQ greater than 1 only represents an increased potential for adverse non-cancer human health effects.[54] An HQ value greater that 1.0 does not substantiate the presence of unacceptable risks. As demonstrated in Table 4-4, contributions from Pee Dee Facility operations are two orders of magnitude below target levels of concern and only account for less than two percent of the cumulative HQ, and as such, do not contribute to a significant incremental increase in human health risks when compared with background mercury concentrations. As a result, there is confidence in the conclusion that no adverse health effects are expected from exposure to emission attributable to the operation of the proposed Pee Dee facility.

In order to provide additional resolution to the risk assessment process and to be more representative, a refined risk analysis was conducted as described below in Section 4.2.

[54] NATA Glossary of Terms – Hazard Index (URL: http://www.epa.gov/nata/gloss.html)

4.2 REFINED RISK ANALYSIS

As discussed in Section 2.0, the screening-level assessment was initially conducted to provide a conservative estimate of potential human health impacts and to identify opportunities for reducing uncertainty through incorporating site-specific data. To this end, additional risk analysis was performed as a refinement to the screening level analysis and specifically intended to reduce uncertainty by more closely following the USEPA HHRAP guidance document, including incorporation of additional site-specific data. In addition, all three forms of mercury including elemental mercury, mercuric chloride, and methylmercury were evaluated as individual COPCs in the refined analysis. The refined risk analysis fully implements the HHRAP guidance document which includes specific methodology for modeling the fate and transport of mercury emissions from combustion sources and includes detailed consideration of site-specific factors that influence exposure and risk. The HHRAP guidance document was issued final in 2005 and has undergone extensive internal review by USEPA and external public review and comment. The HHRAP guidance document contains methodologies and equations specifically designed to conduct site-specific risk assessments. The HHRAP document relies on a combination of site-specific data inputs and conservative defaults to promote the generation of defensible human health risk estimates. Detailed calculations for the refined risk analysis are provided in Appendix B of this report. Key assumptions and important aspects of the refined level risk assessment include:

- Loss to the global mercury cycle was considered in order to provide more appropriate estimates.
- Additional mercury loading to the water body was considered through a number of mechanisms: diffusion, runoff from impervious area, runoff from pervious area, erosion, internal transfer.
- Mercury loss mechanisms were also considered including volatilization and benthic burial rates.
- The accumulation of mercury deposition over time and steady state concentration was considered by implementing the HHRAP equations, including the time period over which deposition occurs , tD (30 years).[55]
- Additional mercury loadings from the proposed ash pond wastewater discharges were also considered in this analysis.
- In addition to fish ingestion, the drinking water and inhalation exposure pathways were also considered for the fisher exposure scenarios.
- Subsistence Fisher Adult and Subsistence Fisher Child exposure scenarios were considered in addition to the Fisher Adult and Fisher Child exposure scenarios to provide more conservative risk estimates (higher fish consumption rates).
- Risk estimates were developed for an "effective" watershed area specifically selected close to the facility and to include areas of maximum concentration and deposition. Selection was also based on consideration of 10 digit HUCs to maintain hydraulic conductivity of the watershed area.

[55] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities,* September 2005, EPA 530-R-05-006, Appendix B, Table B-4-1, p. B-168.

- Site – specific volumetric flow rate through the water body (Vf_x') was obtained using average discharge data (1997-2003) for the Pee Dee watershed.[56]
- Inclusion of "worst case" scenario based on consideration of potential future land use and exposure activities.

4.2.1 ESTIMATING MEDIA CONCENTRATIONS

Surface water bodies and their associated watersheds are the key determinants for evaluating the fisher exposure scenarios and serve as the sources of fish ingestion and drinking water consumption. Information on area water bodies was obtained by reviewing data collected and maintained by the USGS Hydrologic Research and Development (HRD) division. This dataset includes detailed information on defined hydrologic units including water bodies and associated watersheds. Numerous water bodies were identified in the assessment area, however, final selection was based on criteria designed to ensure representativeness while maintaining conservatism:

- Water bodies and associated watersheds should be located in areas with the highest modeled impact.
- Water bodies should reasonably be expected to support the relevant exposure setting including the ability to sustain a harvestable fish population and serve as an existing or reasonable potential future drinking water intake.

Based on consideration of these factors and to provide an additional level of conservatism for evaluating fish ingestion from the Pee Dee River, an "effective" watershed was defined to evaluate the fisher exposure scenarios including both the fish ingestion and drinking water pathways. Based on the AERMOD-predicted deposition and concentration results described in Section 3, the concentration of mercury in the selected surface water bodies was estimated. Surface water calculations were then used to estimate the fish concentrations as follows.

For the refined analysis, the total mercury load to the water body was estimated through a number of loading mechanisms as described in Section 4.1.1.1, and apportioned into mercuric chloride and methylmercury following HHRAP guidance. In addition to mercury loadings associated with air emissions, loading from the proposed wastewater discharge (L_{Dis}) was also included in the refined risk analysis. The MS Excel spreadsheets used to complete risk modeling for the refined analysis were modified to include this additional loading term as presented in Equation 9.

$$L_T' = L_{DEP}' + L_{dif} + L_{RI} + L_R + L_E + L_I + L_{Dis} \qquad (9)$$

In the refined analysis, each loading mechanism was estimated as described below in Equations 10-14.[57, 58, 59, 60, 61]

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[56] Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina (URL: www.waterdata.usgs.gov)

[57] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities,* September 2005, EPA 530-R-05-006, Appendix B, Table B-4-8, p. B-201.

$$L'_{DEP} = Q'_{(total)} \cdot \left[F_v \cdot Dytwv_{wb} + (1 - F_v) \cdot Dytwp_{wb}\right] \cdot A_w \quad (10)$$

Where,
L'_{DEP} = Deposition loading to water body (kg/yr).
$Q'_{(total)}$ = Total Mercury Emission Rate for mercuric chloride (i.e., divalent) – includes consideration of loss to the mercury global cycle.
A_w = Area of surface water body (m^2).
F_v = Fraction of divalent mercury in the vapor phase (unitless).
$Dytwv_{wb}$ = Total (wet and dry) vapor phase unitized yearly deposition over water body (s/m^2-yr).
$Dytwp_{wb}$ = Total (wet and dry) particle bound unitized yearly deposition over water body (s/m^2-yr).

$$L_{dif} = \frac{K_v \times Q'_{(total)} \times F_v \times Cyvw \times A_w \times 1 \times 10^{-6}}{\frac{H}{R \times T_{wk}}} \quad (11)$$

Where,
L_{dif} = Vapor phase diffusion load to surface water body (kg/yr).
K_v = Overall transfer rate coefficient (m/yr).
Cyvw = Unitized yearly average air concentration from vapor phase (µg-s/g-m^3).
H = Henry's Law constant (atm-m^3/mol).
R = Universal gas constant (atm-m^3/mol-K).
T_{wk} = Water body temperature (K)

$$L_{RI} = Q'_{(total)} \times \left[F_v \times Dytwv_{wb} + (1 - F_v) \times Dytwp_{wb}\right] \times A_I \quad (12)$$

Where,
L_{RI} = Runoff load from impervious area of watershed (kg/yr).
A_I = Area of impervious portion of watershed (m^2).

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[58] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix B, Table B-4-12, p. B-215.

[59] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix B, Table B-4-9, p. B-204.

[60] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix B, Table B-4-10, p. B-207.

[61] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix B, Table B-4-11, p. B-211.

$$L_R = RO \times (A_L - A_I) \times \frac{Cs_{tD} \times BD}{\theta_{sw} + Kd_s \times BD} \times 0.01 \tag{13}$$

Where,
L_R = Runoff load from pervious area of watershed (kg/yr).
BD = Soil bulk density (g soil/cm^3 soil).
θ_{sw} = Soil volumetric water content (mL water/cm^3 soil).
Kd_s= Soil-water partition coefficient (cm^3 water/g soil).
Cs_{tD} = Highest average soil concentration at time tD, (g mercury/kg soil).
A_L = Total watershed area (m^2).

$$L_E = X_e \times (A_L - A_I) \times SD \times ER \times \frac{Cs_{tD} \times BD}{\theta_{sw} + Kd_s \times BD} \times 0.001 \tag{14}$$

Where,
L_E = Soil erosion load (kg/yr).
X_e = Unit soil loss (kg soil/m^2-yr).
SD = Watershed sediment delivery ratio (unitless).
ER = Soil enrichment ratio (unitless).

L_I, the loading from internal transfer is considered to be zero for this study as recommended by the HHRAP.[62] The loading due to the proposed wastewater discharges from the plant was calculated as a function of the concentration of mercury in wastewater discharges (C_{Dis}) from the facility and the proposed volumetric flow rate of the wastewater discharges (V_{Dis}).[63]

The highest average soil concentration (Cs_{tD}) at time (tD) is an important parameter to account for accumulation of mercury in soil (until it reaches steady state concentration) and the subsequent loadings to the water body (runoff from pervious areas, erosion). Cs_{tD} is estimated based on Equation 15.

$$Cs_{tD} = \frac{Ds \times \left[1 - e^{-ks \cdot tD}\right]}{ks} \tag{15}$$

Where,
Ds = Soil Deposition (mg mercury/kg soil-yr)
ks = Mercury soil loss constant due to all processes

[62] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities,* September 2005, EPA 530-R-05-006, Chapter 5, Section 5.7.1, p. 5-63.

[63] MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper.

The total water concentration (C'_{wtot}) is calculated by modifying Equation 3 to accommodate for the loading and volumetric flow contribution from the proposed facility wastewater discharges as shown below in Equation 16.

$$C'_{wtot} = \frac{L'_T}{(Vf'_x + V_{Dis}) \times f_{wc} + k_{wt} \times A_w \times (d_{wc} + d_{bs})} \tag{16}$$

One of the important parameters and factors affecting the fraction of mercury available in the water column is f_{wc} (described in Section 4.1.1.1). f_{wc} is calculated based on Equation 17.[64]

$$f_{wc} = \frac{(1 + Kd_{sw} \times TSS \times 1 \times 10^{-6}) \times d_{wc} / d_z}{(1 + Kd_{sw} \times TSS \times 1 \times 10^{-6}) \times d_{wc} / d_z + (\theta_{bs} + Kd_{bs} \times C_{BS}) \times d_{wc} / d_z} \tag{17}$$

Where,
Kd_{sw} = Suspended sediments/surface water partition coefficient (L water/kg suspended sediment).
TSS = Total suspended solids concentration (mg/l).
d_z = Total water body depth (m).
θ_{bs} = Bed sediment porosity.
Kd_{bs} = Bed sediment/sediment pore water partition coefficient (L water/kg bottom sediment).
C_{BS} = Bed sediment concentration (g/cm^3).

The total water column mercury concentration (C'_{wctot}) was calculated using the total water concentration (C'_{wtot}), f_{wc} in equation 18.[65] A portion of the C'_{wctot} goes into the dissolved phase (C'_{dw}) as shown in equation 19, where it is available for uptake by the fish (has a potential to bio-accumulate), and subsequent uptake by humans consuming fish and also via drinking water .[66]

$$C'_{wctot} = f_{wc} \times C'_{wtot} \times \frac{d_{wc} + d_{bs}}{d_{wc}} \tag{18}$$

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[64] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix B, Table B-4-16, p. B-230.

[65] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix B, Table B-4-23, p. B-257.

[66] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix B, Table B-4-14, p. B-260.

$$C'_{dw} = \frac{C'_{wctot}}{1 + Kd_{sw} \times TSS \times 1 \times 10^{-6}} \quad (19)$$

The methylmercury concentration ($C'_{dw(MeHg)}$) is calculated as 15% of C'_{dw} to account for the speciation split in water body as discussed above in Section 4.1.1.1. The subsequent methylmercury concentration in fish (C'_{fish}) is calculated using the BAF and equation 5 from Section 4.1.1.1. Table 4-5 outlines the methylmercury concentration in fish (due to impact of mercury emissions from Pee Dee facility) and compares it to the US EPA methylmercury criterion and fish tissue levels for the Little Pee Dee River.

TABLE 4-5 SUMMARY OF METHYLMERCURY CONCENTRATIONS- REFINED

Type of Concentration	Value (mg methlymercury / kg fish tissue)
Total concentration of methylmercury in Fish due to emissions from Pee Dee Facility	5.88E-04
US EPA Methlymercury water criterion†	0.30
Median concentration of methylmercury in fish for Little Pee Dee River*	0.89
Highest concentration of methylmercury in fish for Little Pee Dee River*	7.00

† Fish Tissue Residue Criterion (TRC) as specified in p. 14, Sec 3.1.2.2 (Chapter 3), Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

* Mercury concentration in fish selected from the USEPA fish advisory database for the Little Pee Dee river. Little Pee Dee river tissue reports were selected based on its proximity of the river to the facility's location. (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on)

4.2.2 QUANTIFYING AND ESTIMATING EXPOSURE

As discussed in Section 2.3, exposure scenarios are intended to define the combination of exposure pathways to which a human receptor may be exposed and forms the basis for estimating the type and magnitude of human exposure to COPCs. Based on consideration of current and reasonable potential future human exposure activities in the assessment area (i.e., area surrounding the facility) and based on the knowledge that U.S. EPA considers the fish ingestion pathway the primary (i.e., 99.9%) route of exposure in humans,[67] The Fisher Adult and Fisher Child scenarios were selected as the basis for estimating potential human health. In addition to the Fisher Adult and Fisher Child exposure scenarios evaluated, the Subsistence Fisher Adult and Subsistence Fisher Child scenarios were also included to provide an additional level of conservatism. Ingestion rates used to evaluate subsistence level fish ingestion are consistent with the HHRAP recommended ingestion rates. The intake from ingestion of fish is calculated as described in equation 6 of Section 4.1.2. As previously

[67] U.S. EPA, *Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion*, August 2006, EPA 823-B-04-001, Section 3.2.1.1, p. 27. (URL: http://www.epa.gov/waterscience/criteria/methylmercury/guidance-draft.html)

discussed, the drinking water exposure pathway was also included in the refined analysis. The ingestion from drinking water is estimated using equation 20. [68]

$$I_{dw} = \frac{C'_{dw} \times CR_{dw} \times F_{dw}}{BW} \quad (20)$$

Where,
I_{dw} = Daily intake of methylmercury from drinking water (mg/kg-day).
CR_{dw} = Rate of consumption of drinking water (L/day).
F_{dw} = Fraction of drinking water that is contaminated.
BW = Body weight (kg)

The total intake of methylmercury is calculated based on equation 21. The ingestion from soil (I_{soil}), above ground produce (I_{ag}), beef (I_{beef}), pork (I_{pork}), milk (I_{milk}), eggs (I_{eggs}) and poultry ($I_{poultry}$) were not considered in this study, since fish ingestion is considered as the primary exposure route (99.9 %) for methylmercury.[69] Based on these assumptions equation 21 is reduced to equation 22. Total daily intake for both the Fisher Adult and Fisher Child and the Subsistence Fisher Adult and Subsistence Fisher Child exposure scenarios are summarized in Tables 4-6 and 4-7.

$$I_{ingestion\,(MeHg)} = I_{fish} + I_{dw} + I_{ag} + I_{beef} + I_{milk} + I_{poultry} + I_{eggs} + I_{pork} \quad (21)$$

$$I_{ingestion\,(MeHg)} = I_{fish} + I_{dw} \quad (22)$$

TABLE 4-6 SUMMARY OF METHYLMERCURY DAILY INTAKE FOR FISHER ADULT AND FISHER CHILD EXPOSURE SCENARIOS - REFINED

Parameter	Value		Units
	Fisher Adult	Fisher Child	
Total Daily Intake of Methylmercury (due to the impact of emissions from Pee Dee Facility)	1.28E-07	2.43E-07	mg/kg-day
Total Daily Intake of Methylmercury (due to median background mercury concentration)†	1.93E-04	3.68E-04	mg/kg-day
Total Daily Intake of Methylmercury (due to highest background mercury concentration)†	1.52E-03	2.89E-03	mg/kg-day

† These ingestion rates are based on the median, highest fish concentration in the USEPA fish advisory database for the Little Pee Dee River (Refer to Table 4-5)

[68] U.S. EPA, *Human Health Risk Assessment Protocol (HHRAP) for Hazardous Waste Combustion Facilities*, September 2005, EPA 530-R-05-006, Appendix C, Table C-1-5, p. C-17.

[69] U.S. EPA, *Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion*, August 2006, EPA 823-B-04-001, Section 3.2.1.1, p. 27. (URL: http://www.epa.gov/waterscience/criteria/methylmercury/guidance-draft.html)

TABLE 4-7 SUMMARY OF METHYLMERCURY DAILY INTAKE FOR SUBSISTENCE FISHER ADULT AND SUBSISTENCE FISHER CHILD EXPOSURE SCENARIOS - REFINED

Parameter	Value		Units
	Subsistence Fisher Adult	Subsistence Fisher Child	
Total Daily Intake of Methylmercury (due to the impact of emissions from Pee Dee Facility)	7.36E-07	5.18E-07	mg/kg-day
Total Daily Intake of Methylmercury (due to median background mercury concentration)†	1.11E-03	7.83E-04	mg/kg-day
Total Daily Intake of Methylmercury (due to highest background mercury concentration)†	8.75E-03	6.16E-03	mg/kg-day

† These ingestion rates are based on the median, highest fish concentration in the USEPA fish advisory database 7for the Little Pee Dee River (Refer to Table 4-5)

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4.2.3 CHARACTERIZING RISK AND HAZARD

As discussed in Section 4.1.3, risk and hazard characterization forms the final step in the risk evaluation process. Risk characterization for estimating the hazard quotient for the refined risk analysis is consistent with the screening-level analysis described in Section 4.1.3. Hazard quotients were calculated using exposure parameters presented in Table 4-3 in Section 4.1.3 and total daily intakes from Tables 4-6 and 4-7 of Section 4.2.2.

Observed differences in results between the screening level and refined risk analysis are attributed to the individual refinements listed in Section 4.2. Exposure scenarios evaluated in the refined risk analysis include:

- Fisher Adult and Fisher Child – based on “effective” portion of Pee Dee River watershed.
- Subsistence Fisher Adult and Subsistence Fisher Child – based on “effective” portion of Pee Dee River watershed.
- Subsistence Fisher Adult and Subsistence Fisher Child – based on “worst case” scenario.

Results presented in Tables 4-8, 4-9, and 4-10 include risk estimates based on potential impacts from Pee Dee Facility Operations as well as consideration of measured background concentrations.[70] Calculated hazard quotients as a result of exposure to Pee Dee facility mercury emissions for the exposure scenarios included in the refined analysis range from 1.2E-03 to 7.1E-03 for the Fisher Adult exposure scenario (both Fisher, Subsistence) and 2.3E-03 to 5.0E-03 for the Fisher Child exposure scenario (both Fisher, Subsistence).

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[70] Mercury concentration in fish selected as the median, highest value from the U.S. EPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on)

In addition to results based on exposure to mercury emission from the Pee Dee facility, consideration of mercury background concentrations was also included in the refined level analysis. This consideration was included to provide a frame of reference for understanding the potential impacts of Pee Dee Facility operations in comparison with background mercury concentrations and to further support the risk communications process. While the background methylmercury concentration results in a calculated HQ greater than 1.0, contributions from Pee Dee Facility operations result in an insignificant incremental increase in the overall cumulative HQ. In the case of mercury background concentrations it should further be noted that an HQ greater than 1 only represents an increased potential for adverse noncancer human health effects.[71] An HQ value greater that 1.0 does not substantiate the presence of unacceptable risks. Furthermore, hazards calculated using background concentrations are based on the median and highest measured values and do not reflect likely exposure conditions associated with fish harvesting and consumption. As demonstrated in Tables 4-8, 4-9, and 4-10, contributions from Pee Dee Facility operations are two to three orders of magnitude below target levels of concern, and as such, do not contribute to a significant incremental increase in human health risks when compared with background mercury concentrations. As such, there is confidence in the conclusion that no adverse health effects are expected from exposure to emission attributable to the operation of the proposed Pee Dee facility.

Detailed results for the individual exposure scenario evaluated in the refined assessment are described below. Table 4-8 presents results for the Fisher Adult and Fisher Child exposure scenarios.

TABLE 4-8 SUMMARY OF HAZARD QUOTIENTS FOR FISHER ADULT AND FISHER CHILD SCENARIOS – REFINED

Parameter	Value		Hazard Quotient less than 1	
	Fisher Adult	Fisher Child	Fisher Adult	Fisher Child
Impact due to Emissions from Pee Dee Facility Hazard Quotient (Fish Ingestion)	1.2E-03	2.3E-03	**YES**	**YES**
Impact due to Median Background Concentration Hazard Quotient[1] (Fish Ingestion, Background Concentration)	1.9	3.5	**NO**	**NO**
Impact due to Highest Background Concentration Hazard Quotient[1] (Fish Ingestion, Background Concentration)	14.6	27.7	-	-
Pee Dee Emissions as % contribution to cumulative HQ				
Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	**0.07%**	**0.07%**	-	-
Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	**0.01%**	**0.01%**	-	-

[1]This Hazard Quotient is calculated based on the ingestion rate of the fish with median, highest methylmercury concentration in the Little Pee Dee River. (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on)

[71] NATA Glossary of Terms – Hazard Index (URL: http://www.epa.gov/nata/gloss.html)

As shown in Table 4-8, the hazard quotient associated with exposure to mercury emissions from the Pee Dee facility operations are significantly below than the HQ target level of 1.0 for the Fisher Adult and Fisher Child exposure scenarios. As such, there is confidence in the conclusion that no adverse health effects are expected from exposure to emissions attributable to the operation of the proposed Pee Dee facility. These results also reinforce the significant level of human health protectiveness offered by the DHEC approved mercury permit limit.

Also demonstrated in Table 4-8, contributions from Pee Dee Facility operations are three orders of magnitude below target levels of concern, and as such, do not contribute to a significant incremental increase in human health risks when compared with background mercury concentrations.

Results for the Subsistence Fisher Adult and Subsistence Fisher Child are presented in Table 4-9, including potential impacts from Pee Dee Facility Operations as well as consideration of measured background concentrations from the Little Pee Dee River.

TABLE 4-9 SUMMARY OF HAZARD QUOTIENTS FOR SUBSISTENCE FISHER ADULT AND SUBSISTENCE FISHER CHILD SCENARIOS – REFINED

Parameter	**Value**		**Hazard Quotient less than 1**	
	Subsistence Fisher Adult	Subsistence Fisher Child	Subsistence Fisher Adult	Subsistence Fisher Child
Impact due to Emissions from Pee Dee Facility Hazard Quotient (Fish Ingestion)	7.1E-03	5.0E-03	**YES**	**YES**
Impact due to Median Background Concentration Hazard Quotient[1] (Fish Ingestion, Background Concentration)	10.7	7.5	**NO**	**NO**
Impact due to Highest Background Concentration Hazard Quotient[1] (Fish Ingestion, Background Concentration)	83.9	59.1	**NO**	**NO**
Pee Dee Emissions as % contribution to cumulative HQ				
Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	**0.07%**	**0.07%**	-	-
Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	**0.01%**	**0.01%**	-	-

[1]This Hazard Quotient is calculated based on the ingestion rate of the fish with median, highest methylmercury concentration in the Little Pee Dee River. (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on)

As shown in Table 4-9, the hazard index associated with mercury emissions from the Pee Dee facility are significantly below than the HQ target level of 1.0 for the Subsistence Fisher Adult and Subsistence Fisher Child exposure scenarios. As such, there is confidence in the conclusion that no adverse health effects are expected from exposure to emissions attributable to the operation of the proposed Pee Dee facility. These results also reinforce the level of human health protectiveness offered by the DHEC approved mercury permit limit.

4.2.4 "WORST CASE" POTENTIAL FUTURE EXPOSURE SCENARIO

The refined analysis was further extended to develop risk estimates based on "worst case" assumptions to estimate highly conservative results for evaluating potential future scenarios and to bound upper end risk estimates. It should be noted that this exposure scenario is not based on actual site-specific conditions, but rather based on a contrived scenario consisting of a one acre lake located at the point to maximum concentration and deposition. Detailed assumptions used to support evaluation of this analysis include the following:

- Water body area assumed to be 1 acre (4,046 m^2) lake with an associated 10 acre watershed (40,460 m^2).
- Assumed 1 acre water body could support a fish population capable of sustaining subsistence level consumption rates.
- Volumetric flow rate set equal to zero to remove additional dilution term.

Table 4-10 presents results for the Subsistence Fisher Adult and Subsistence Fisher Child exposure scenarios based on the "worst case" exposure scenario. The highest calculated hazard quotient (i.e., non cancer risk estimate) based on mercury emission from Pee Dee Facility operations is 7.5E-02 and is based on the "worst case" Subsistence Fisher Adult exposure scenario described below in Section 4.2.4.

As shown in Table 4-10, the hazard index associated with mercury emissions from the Pee Dee facility operations are significantly below than the HQ target level of 1.0 for the Subsistence Fisher Adult and Subsistence Fisher Child "worst case" exposure scenarios. As such, there is confidence in the conclusion that no adverse health effects are expected from exposure to emissions attributable to the operation of the proposed Pee Dee facility. These results also reinforce the level of human health protectiveness offered by the DHEC approved mercury permit limit.

TABLE 4-10 SUMMARY OF HAZARD QUOTIENTS FOR WORST CASE SCENARIO (REFINED ANALYSIS)

Parameter	Value		Hazard Quotient less than 1	
	Subsistence Fisher Adult	Subsistence Fisher Child	Subsistence Fisher Adult	Subsistence Fisher Child
Impact due to Emissions from Pee Dee Facility Hazard Quotient (Fish Ingestion)	7.5E-02	5.3E-02	**YES**	**YES**
Impact due to Median Background Concentration Hazard Quotient[1] (Fish Ingestion, Background Concentration)	10.7	7.5	**NO**	**NO**
Impact due to Highest Background Concentration Hazard Quotient[1] (Fish Ingestion, Background Concentration)	83.9	59.1	**NO**	**NO**
Pee Dee Emissions as % contribution to cumulative HQ				
Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	**0.70%**	**0.70%**	-	-
Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	**0.09%**	**0.09%**	-	-

[1]This Hazard Quotient is calculated based on the ingestion rate of the fish with median, highest methylmercury concentration in the Little Pee Dee River. (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on)

5. IDENTIFYING AND INTERPRETING UNCERTAINTIES

Uncertainty is inherent in any risk assessment process primarily due to the complexities associated with modeling the movement of chemicals in the environment, through human exposure pathways, and quantifying exposure. As discussed throughout this document key assumptions were designed to over-estimate, rather than under-estimate human health risks. Consideration was also given to conservative assumptions to balance the magnitude of overestimation with the goal of producing meaningful and realistic estimates of risk. Uncertainties and limitations of the risk assessment process are discussed in detail in Chapter 8 of the HHRAP and also further described in each separate chapter of the HHRAP document. Therefore, this risk assessment will not reiterate that lengthy discussion, but will complement it by addressing specific key areas of interest which were identified during completion of this risk assessment and pertinent to overall risk results. These issues are discussed in detail in the following sections.

5.1 MERCURY EMISSIONS

As discussed in Section 2.0, it was necessary to use surrogate emissions speciation data to calculate representative speciated mercury emission rates for this facility. Although the use of site-specific emissions rates and mercury speciation data is preferred, collecting this information for the proposed Pee Dee Facility was not possible. The use of surrogate emissions data is a source of uncertainty, therefore careful consideration was given to the selection of representative emissions data to limit this uncertainty. To accomplish this objective and estimate representative emission rates, actual measured speciation test data for 73 coal-based power plants in the United States were reviewed and used as the basis for estimating mercury speciation profiles. Final selection of representative source types was limited to sources with similar characteristics including coal type and APCDs. This approach is believed to be representative of proposed facility operations and is therefore not anticipated to have a significant impact on uncertainty or risk estimates.

Additionally, as discussed in Section 2.2, DHEC issued the final construction permit lowering mercury emissions for a single boiler from the proposed rate of 57.8 lbs/yr to 46.3 lbs/yr. In consideration of risk assessment objectives, the higher emission rate limit of 57.8 lbs/yr for each boiler was used in air dispersion modeling and subsequent risk (both screening and refined) analysis to ensure conservative estimates were used throughout the process. For these reasons, the selected emission rates are expected to yield higher than actual risk estimates for both the screening-level and refined risk analysis when compared with actual facility operations. Furthermore, power generation is demand driven and therefore may not require the Pee Dee Facility to operate at 100% design capacity 365 days a year. Seasonal variation in operation or an unforeseen decrease in demand would also results in decreased actual annual emissions, which in turn would produce lower risk estimates.

Another important assumption (screening analysis only) made in estimating speciated mercury emission rates for the facility was that no adjustments were made to emission rates to account for loss to the mercury global cycle. As discussed in Section 2.2.1, a vast majority of mercury exiting the stack doesn't readily deposit, but is vertically diffused to the free atmosphere, transported outside the study area and into the global cycle. This assumption, as applied to the screening level analysis, results in an overestimation of actual emissions and therefore an overestimation of risk.

Loss mechanisms attributable to the mercury global cycle are well documented and discussed in detail in the USEPA Mercury Report to Congress and the HHRAP. To remain consistent with these documents and to reduce the uncertainty associated with the impact of overestimating risk, adjustments for loss to the global cycle were included as part of the refined risk analysis. Section 2.2.1 provides additional information on the mercury global cycle and is further illustrated in Figure 2-1. This assumption is believed to reduce uncertainty and provide more realistic risk estimates.

5.2 AIR DISPERSION MODELING

The USEPA approved air dispersion model AERMOD, was used to predict concentration and deposition rates across the assessment area. The complexities and site-specific nature of air dispersion modeling make determining the direction of any biases difficult. While the exact impact of the air dispersion modeling uncertainties on risk results is unknown, the selection of conservative model inputs and outputs help to ensure that hazards were not underestimated. The following areas of uncertainties in air dispersion modeling are discussed below.

5.2.1 GAUSSIAN DISPERSION MODELS

The Hg deposition modeling analysis that was performed in AERMOD has certain uncertainties associated with it. The steady-state, Gaussian dispersion model has inherent uncertainties in predicting concentrations or deposition values at a given receptor point at a given time.[72] Evaluation studies for the models typically compare maximum monitored values to maximum modeled values, independent of time or space, since the models yield generally conservative predictions of the overall magnitude of concentrations on the whole. The comparison of monitored-to-modeled concentrations at specific locations and times is not as favorable. This is one of the reasons that models are run over several meteorological years, using large receptor grids, extending in all directions. The Pee Dee facility consists of tall stacks in a rural setting with flat terrain. Those factors somewhat simplify the computations in the AERMOD modeling analysis and improve the overall accuracy of the predictions. The use of domain-averaged values rather than specific receptor concentrations also minimizes predictive variability.

The AERMOD model has been evaluated for receptor distances of 50 km or less from the source. The initial modeling analysis for the Pee Dee facility included the full Pee Dee River Basin, which had receptors in excess of 50 km from the facility itself. It was determined that although those locations extend beyond the nominal distance considered for AERMOD, the predictions would be conservative since Gaussian models will predict concentrations at all receptors during all hours, even if the plume would not reach those points in reality.

[72] 40 CFR 51, Appendix W, *Guideline on Air Quality Models*.

5.2.2 LANDUSE CHARACTERIZATION

As described previously, the AERSURFACE-based landuse analyses for the Columbia Airport and Pee Dee facility showed differences in the surface roughness values estimated for the sites. The AERMOD modeling analysis was performed using meteorological data processed with each set of landuse characteristics to determine the "worst-case" meteorological data, which proved to be the data based on the Pee Dee facility landuse. The AERMOD model results will certainly vary with landuse characteristics (namely the surface roughness). The methodologies (e.g. AERSURFACE, subjective analyses of aerial photography) that are used to create estimates of the albedo, Bowen ratio and surface roughness could have an influence on model predictions. The AERMOD predictions used in the risk calculations were based on using the worst-case meteorological data that was generated using current USEPA guidance.[73]

The gaseous deposition of Hg compounds is also a function of landuse in the model, as the computed deposition velocities are related to the land cover at a given location. The predominant landuse types around the Pee Dee facility are agricultural and forest lands. AERMOD only allows the user to enter one landuse category for a given wind direction sector and as such, a modeling analysis was performed using both types to determine the "worst-case" landuse. The forest landuse type yielded the highest model prediction and thus was used in the final AERMOD analyses.

5.2.3 MODELED EMISSION RATES

As described previously, the speciated Hg emission rates were based on the partitioning of the total Hg emission rate as a function of test data for operational boilers using similar coal types and control technologies. The relative percentages of speciated components could vary on a boiler-by-boiler basis, especially for the more technologically-advanced units that are currently being developed. Those changes could change the AERMOD model predictions (either increase or decrease the values), as the emission rates would be directly-affected. The Hg "speciation" for the Pee Dee facility was based on the 57.8 lb/yr per unit value, which was derived from the 10 lb/TW-hr emission rate proposed in Santee Cooper's case-by-case MACT permit application.[74] The final construction permit issued by DHEC is for only 46.3 lb/yr per unit value, representing a 20% reduction from the proposed total Hg emissions in the application. Thus, the modeled values used in the risk calculations are based on conservative Hg emissions estimates.[75]

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[73] URL: http://www.epa.gov/scram001/7thconf/aermod/aermod_implmtn_guide_09jan2008.pdf

[74] *Santee Cooper Case-by-Case MACT Permit Application*, June 30, 2008 (URL: http://www.scdhec.net/environment/baq/docs/SanteeCooper/SanteeCooperCasebyCaseApplicationforPeeDee.pdf).

[75] Bureau of Air Quality, DHEC, *PSD, NSPS (40CFR60), NESHAP (40CFR63) construction permit*, December 16, 2008 (URL: http://www.scdhec.gov/environment/baq/docs/SanteeCooper/permit_2008-12-16.pdf). All permit-related documents are available at http://www.scdhec.gov/environment/baq/SanteeCooper.aspx.

5.3 ESTIMATING MEDIA CONCENTRATIONS

As discussed in Section 2.1, the fate and transport of mercury in the environment is complex and involves numerous mechanisms including mercury reduction, methylation, demethylation, erosion loading, direct deposition, vapor diffusion, dissipation, and benthic burial. The movement of mercury in soils and water bodies affects the overall concentration and ultimately determines the fraction of methylated mercury in water bodies and fish. Assumptions related to these factors and how they contribute to uncertainty are discussed below.

The methylation conversion in surface waters (conversion from divalent to methylmercury) was assumed to be 15% per the HHRAP recommendation as discussed in Section 4.1.1.1. However, methylation rates are known to vary widely and are influenced by numerous site-specific chemical and physical properties. The US EPA study of Hazardous Air Pollutants from Electric Utility Steam Generating Units states that the methylation conversion is typically less than 10%.[76] As described earlier in Section 4.1.1.1, the USGS Study on Mercury contamination has noted that the average methylmercury to total mercury ratio was 0.12 (12%) for the Edisto River in the Santee Basin and Coastal Drainages.[77] This potential variability in reported values is a source of uncertainty, however, the assumption to use the HHRAP recommended default of 15%, is believed to be conservative and therefore overestimates media concentrations and subsequent risk estimates.

Specific to the screening-level assessment, and as discussed in Section 4.1.1.1 it was assumed that all mercury loading to the water body is present in the water column (f_{wc} = 1). The assumption may overestimate or underestimate fish concentrations depending on individual species feeding habits. Estimates for water column feeding fish would be overestimated since 100 % of mercury is assumed to be distributed in the water column, while estimates for bottom feeding (or bed sediment feeding) fish are likely to be underestimated since no mercury is partitioned to the bed sediment. Additionally, the dissipation of mercury in surface water was also not considered (k_{wt} = 0) which would further results in an overestimation of mercury concentration in water and therefore an over-prediction of risk.

Uncertainties associated with these key assumptions and equation input variables were reduced in the refined analysis by fully implementing the HHRAP methodologies, equations, and recommended defaults, which explicitly model the interaction and movement of speciated mercury in air, soil, water, sediment, and fish.

For the refined risk analysis, soil concentration averaged for the time period over which deposition occurs (tD = 30 years) was used in estimating soil concentration loadings from runoff from pervious areas and erosion. The soil concentration incorporates steady state accumulation of mercury and its

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[76] U.S. EPA, Study of Hazardous Air Pollutant Emissions from Electric Utility Steam Generating Units - Final Report to Congress - Volume 1, February 1998, EPA-453/R-98-004a, Section 7.1.3.3, p. 7-14.

[77] USGS, *Contamination of Hydrologic Systems and Related Ecosystems, Water-Resources Investigation Report 99-4018B*, March 1999, Section B, p .147.

subsequent loading to the water body. This assumption is believed to reduce uncertainty and may overestimate the mercury loadings and therefore the subsequent risk estimates.

Additional loss mechanisms not directly quantified in this risk assessment, include re-suspension of mercury from soil and demethylation of methylmercury. The HHRAP recommends that the relevant loss parameter (kse) should be set equal to zero based on the assumption that the amount of soil eroding off the land is countered by a roughly equal amount of soil eroding onto the land from adjacent areas. While this is perhaps a valid assumption for small areas, it is not a valid assumption for the evaluation of a watershed. This explanation is counter to the definition of a watershed, where by its very nature; there is no countering source of erosion into a watershed from areas outside its boundary. The consequence of artificially setting kse = 0, introduces uncertainty and overestimates mercury concentration loading into water bodies which ultimately results in increased risks estimates. Also, not all mercury compounds entering an aquatic ecosystem are methylated, and demethylation reactions as well as volatilization of dimethylmercury decrease the amount of methylmercury available in the aquatic environment. These loss mechanisms are not considered in the HHRAP estimating media concentration equations. Since consideration of these mechanisms would result in a decrease in mercury concentrations, media concentrations and resulting risk estimates are likely overestimated to an unknown degree.

In addition to the fate and transport issues discussed above, another key assumption that directly effects risk estimates (and is a potential source of uncertainty) is the selection of representative watersheds and water bodies for evaluating the fish ingestion and drinking water exposure pathways. For the screening level assessment, the entire watershed for the Pee Dee River was selected for evaluation. While appropriate and representative of site-specific exposure conditions, due to the large size of the Pee Dee River watershed, it is probable that localized segments of the river experience higher impacts from facility operations. These higher localized impacts would result in higher exposure and risk estimates if a fisher concentrated harvesting efforts in this area and on fish species with highly-localized populations.

To reduce this uncertainty two additional steps were taken in the refined analysis, including consideration of 1) an “effective” watershed and water body area selected to include areas of maximum concentration and deposition, and 2) evaluation of a worst case potential future scenario based on a hypothetical one acre pond at the maximum location of modeled impacts. Evaluation of an “effective” watershed is a recommended in the HHRAP when evaluating large watershed systems such as the Pee Dee River watershed. Since the effective watershed and water body area was limited to include areas of maximum modeled concentration and deposition, uncertainties associated with potentially underestimating risks are believed to be significantly reduced. Evaluation of the worst case scenario is believed to actually result in increased uncertainty since estimates are based on a hypothetical location using maximum modeled concentration and deposition values. This scenario was evaluated not to increase uncertainty, but to provide an upper bound estimate relative to the potential for overestimation.

5.4 EXPOSURE SCENARIOS, EXPOSURE, AND RISK ASSESSMENT

As discussed in Section 2.3, exposure scenarios presented in the HHRAP are intended to estimate the type and magnitude of human exposure typical of emission from combustion sources. An exposure scenario is a combination of exposure pathways to which a human receptor may be subjected. In the case of methylmercury, fish ingestion is the predominant exposure pathway. As discussed in Section 4.1.2, fish ingestion rates were used for the Fisher Adult and Fisher Child exposure scenarios for the screening level assessment. While this assumption could result in an under-prediction of risks, two other key assumptions were implemented to minimize this uncertainty. First, the assumption was made that the fisher exposure scenario harvests all of their fish from the Pee Dee River, whereas actual fishers usually harvest fish from multiple lakes and area water bodies. Secondly, the fraction of fish that is contaminated was set to one (i.e., 100%). This assumption likely results in an overestimation of exposure since not all fish in the Pee Dee River will be contaminated, depending on seasonal variability, age, sex, location, and feeding habits.

The potential underestimation of exposure and uncertainty attributable to ingestion rates was further addressed in the refined analysis by including subsistence level fishing. The exposure scenarios recommended in the HHRAP, including the fisher exposure scenarios, are designed with a level of protectiveness and are intended to be representative of not only the general public, but also populations with relatively higher exposures. The subsistence fisher exposure scenario is intended to represent a much smaller portion of the population where fish ingestion comprises the major source of protein in the person's diet. Additionally, no information was identified to indicate the presence of subsistence fishing in the project area. Finally, a fish consumption advisory issued by DHEC for the Pee Dee River is already in place to account for high mercury background concentrations. These advisories are well publicized and posted, which should further reduce the potential for subsistence level ingestion in the local population.

In conclusion, while uncertainty is inherent in the risk assessment process, careful consideration was made to manage this uncertainty while preserving conservative risk estimates. This approach, when coupled with a review of results, builds an additional level of confidence in the overall findings that clearly demonstrate emissions from the Pee Dee Facility do not contribute to a significant increase to the current human health risks.

APPENDIX A – MODELING ANALYSIS FOR TOXIC AIR POLLUTANTS (TAPS)

Comparison of Maximum 24-hour Predicted Concentrations with South Carolina Department of Health and Environmental Control's (SCDHEC) Maximum Allowable Ambient Concentrations (MAAC) for Toxic Air Pollutants

	X Coordinate	Y Coordinate	Year	Highest Predicted 24-Hour Concentration ($\mu g/m^3$) for Emission Rate of 1 g/s
	640.55	3,754.78	1990	1.60E-01

Pollutant	Emission Rate [1] (g/s)	Highest Predicted 24-Hour Concentration [2] ($\mu g/m^3$)	SCDHEC MAAC [3] ($\mu g/m^3$)	Percent of SCDHEC MAAC (%)
1,1,1-Tricholorethane	6.53E-04	1.04E-04	9,550.00	< 0.01%
2,4-Dinitrotoluene	9.14E-06	1.46E-06	1.50	< 0.01%
2-Chloroacetophenone	2.29E-04	3.65E-05	7.50	< 0.01%
5-Methyl Chrysene [4]	7.18E-07	1.15E-07	N/A	N/A
Acenapthene [4]	1.66E-05	2.66E-06	N/A	N/A
Acenapthylene [4]	8.16E-06	1.30E-06	N/A	N/A
Acetaldehyde	1.86E-02	2.97E-03	1,800.00	< 0.01%
Acetophenone	4.90E-04	7.81E-05	TBD	N/A
Acrolein	9.47E-03	1.51E-03	1.25	0.12%
Anthracene [4]	6.86E-06	1.09E-06	N/A	N/A
Benzene	4.24E-02	6.77E-03	150.00	< 0.01%
Benzo(a) anthracene [4]	2.61E-06	4.17E-07	N/A	N/A
Benzo(a) pyrene [4]	1.24E-06	1.98E-07	N/A	N/A
Benzo(b,j,k) fluoranthene [4]	3.59E-06	5.73E-07	N/A	N/A
Benzo(g,h,i)perylene [4]	8.81E-07	1.41E-07	N/A	N/A
Benzyl chloride	2.29E-02	3.65E-03	25.00	0.01%
Biphenyl	5.55E-05	8.86E-06	6.00	< 0.01%
Bis(2-ethylhexyl) phthalate	2.38E-03	3.80E-04	25.00	< 0.01%
Bromoform	1.27E-03	2.03E-04	25.85	< 0.01%
Carbon disulfide	4.24E-03	6.77E-04	150.00	< 0.01%
Chlorobenzene	7.18E-04	1.15E-04	1,725.00	< 0.01%
Chloroform	1.93E-03	3.07E-04	250.00	< 0.01%
Chrysene [4]	3.26E-06	5.21E-07	N/A	N/A
Cumene	1.73E-04	2.76E-05	9.00	< 0.01%
Cyanide	8.16E-02	1.30E-02	125.00	0.01%
Dimethyl sulfate	1.57E-03	2.50E-04	2.50	0.01%
Ethyl benzene	3.07E-03	4.90E-04	4,350.00	< 0.01%
Ethyl chloride	1.37E-03	2.19E-04	26,400.00	< 0.01%
Ethylene dibromide	3.92E-05	6.25E-06	770.00	< 0.01%
Ethylene dichloride	1.31E-03	2.08E-04	200.00	< 0.01%
Fluoranthene [4]	2.32E-05	3.70E-06	N/A	N/A
Fluorene [4]	2.97E-05	4.74E-06	N/A	N/A
Formaldehyde	7.83E-03	1.25E-03	15.00	< 0.01%
Hexane	2.19E-03	3.49E-04	900.00	< 0.01%
Hydrochloric acid	1.96E+00	3.13E-01	175.00	0.18%
Hydrogen fluoride	2.45E-01	3.91E-02	N/A	N/A
Indeno(1,2,3-cd) pyrene [4]	1.99E-06	3.18E-07	N/A	N/A
Isophorone	1.89E-02	3.02E-03	250.00	< 0.01%
Methyl bromide	5.22E-03	8.34E-04	100.00	< 0.01%
Methyl chloride	1.73E-02	2.76E-03	515.00	< 0.01%
Methyl ethyl ketone	1.27E-02	2.03E-03	14,750.00	< 0.01%
Methyl hydrazine	5.55E-03	8.86E-04	1.75	0.05%
Methyl methacrylate	6.53E-04	1.04E-04	10,250.00	< 0.01%
Methyl ter butyl ether	1.14E-03	1.82E-04	N/A	N/A
Methylene chloride	9.47E-03	1.51E-03	8,750.00	< 0.01%
Naphthalene	4.24E-04	6.77E-05	1,250.00	< 0.01%
PCDD/PCDF (total)	5.75E-08	9.17E-09	N/A	N/A
Phenanthrene [4]	8.81E-05	1.41E-05	N/A	N/A
Phenol	5.22E-04	8.34E-05	190.00	< 0.01%
Propionaldehyde	1.24E-02	1.98E-03	N/A	N/A
Pyrene [4]	1.08E-05	1.72E-06	N/A	N/A
Styrene	8.16E-04	1.30E-04	5,325.00	< 0.01%
Tetrachloroethylene	1.40E-03	2.24E-04	3,350.00	< 0.01%
Toluene	7.83E-03	1.25E-03	2,000.00	< 0.01%
Vinyl acetate	2.48E-04	3.96E-05	176.00	< 0.01%
Xylenes	1.21E-03	1.93E-04	4,350.00	< 0.01%
Antimony	5.88E-04	9.38E-05	2.50	< 0.01%
Arsenic	1.34E-02	2.14E-03	1.00	0.21%
Beryllium	6.86E-04	1.09E-04	0.01	1.09%
Cadmium	1.66E-03	2.66E-04	0.25	0.11%
Chromium (all)	1.11E-02	1.77E-03	2.50	0.07%
Cobalt	3.26E-03	5.21E-04	0.25	0.21%
Manganese	1.60E-02	2.55E-03	25.00	0.01%
Mercury	1.66E-03	2.65E-04	0.25	0.11%
Nickel	9.14E-03	1.46E-03	0.50	0.29%
Selenium	4.24E-02	6.77E-03	1.00	0.68%
Total POM	1.98E-04	3.16E-05	160.00	< 0.01%

1. Emission rates equal boiler coal usage mutiplied by AP-42 emission factors. Emission factors taken from AP-42, Section 1.1, Bituminous and Subbituminous Coal Combustion, September 1998.
2. Highest predicted 24-hour concentration for each pollutant calculated as the highest predicted 24-hour concentration for an emission rate of 1 g/s multiplied by the emission rate for each pollutant.
3. SCDHEC 24-hour average Maximum Allowable Ambient Concentrations (MAAC). Refer to http://www.scdhec.gov/environment/baq/docs/modeling/modguide.pdf.
4. Pollutant is a polycyclic organic matter (POM).

APPENDIX B – RISK ASSESSMENT CALCULATIONS

Table A-1. Air Parameters

Parameter	Symbol	Value	Units
Pee Dee River Basin Modeling Area[1]	A_w	30,166	km^2
Surface Deposition Rate (due to emissions from Pee Dee Facility)[2]	SDR	4.40E-02	$\mu g/m^2/yr$

[1] The Pee Dee River water basin area was determined using digital mapping available from the USGS National Hydrography Dataset (URL: **http://nhd.usgs.gov/data.html**).

[2]Modeling Results of AERMOD Model Runs (115.6 lb/yr - Total Mercury Emissions).

Table A-2. Water Parameters

Parameter	Symbol	Value	Units
Conversion of Hg to MeHg[1]	% MeHg	15.00	%
Annual Precipitation (Average 30 yr)[2]	P	1.14	m/yr
Volumetric flow of water in watershed[3]	Vf_x	3.43E+10	m^3/yr
Fraction of Mercury (water) concentration in the water column[4]	f_{wc}	100.00	%

[1]Based on values as per Section 2.3.5.3, pp. 2 - 52 (Chapter 2) of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.
[2]Monthly Stations Normals of Temperature, Precipitation and Heating and Cooling Degree Days (1971-2000) for South Carolina by National Oceanic and Atmospheric Administration (Feburary 2002), the Florence RGNL AP Site was chosen (closest to Pee Dee Facility).
[3] Volumteric flow of water in watershed (m^3/yr) = Annual Precipitation (m/yr) * Area of Watershed (m^2).
[4]All the mercury present in the water body is assumed to be in the water column for conservative estimates.

Table A-3. Ingestion Parameters

Parameter	Symbol	Value		Units
		Fisher Adult[1]	Fisher Child[2]	
Consumption Rate of Fish	CR_{fish}	2.17E-04	4.13E-04	kg/kg-day body weight
Fraction of Fish that is contmainated[3]	F_{fish}	100	100	%

[1]Based on the Total Fish Consumption for the South Atlantic Region (Table 10-1, Appendix 10A, Exposure Factors Handbook by USEPA, August 1997) for an adult (15.2 g/adult) with an average body weight of adult as 70 kg (Table C-1-5, Appendix C, HHRAP by USEPS, September 2005).
[2]Based on the Mean Fish Consumption for the Age Group of 0-9 years (Table 10-2, Appendix 10A, Exposure Factors Handbook by USEPA, August 1997) for a child (6.2g/child) with an average body weight of a child as 15 kg (Table C-1-5, Appendix C, HHRAP by USEPA, September 2005).

Table A-4. Site Specific Bio - accumulation factor

$$\boxed{C_{fish_{(MeHg)}} = C_{dw_{(MeHg)}} \times BAF_{fish_{(MeHg)}}}$$ **Eqn A-1**

Equation A-1 is based on the equation outlined in Table B-4-27, pp. B-270 (Appendix B), HHRAP by USEPA, September 2005.

Parameter	Symbol	Value	Units
Bio - Accumulation factor[4]	$BAF_{fish\ (MeHg)}$	2.67E+06	L/kg of fish tissue

[4] Bio accumulation factor for Trophic Level 4 fish was obtained from Section 3.1.3.1.3, p. 20 (Chapter 3), Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion by USEPA, August 2006.

Table A-5. Risk and Hazard Parameters

Parameter	Symbol	Value		Units
		Fisher Adult	Fisher Child	
Reference Dose (Oral / Ingestion)[1]	RfD	1.00E-04	1.00E-04	mg/kg-day
Exposure Duration[2]	ED	30	6	yrs
Averaging Time[2]	AT	30	6	yrs
Exposure Frequency[2]	EF	350	350	days/yr

[1]Value based on HHRAP Companion Access Database for methylmercury
(URL: **http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb**).
[2]Based on the equation outlined in Table C-1-8, pp. C-26 and C-27 (Appendix C), HHRAP by USEPA, September 2005.

1. Deposition in Water

$$\boxed{L_T = SDR \times A_w}$$ **Eqn 1-1**

Total Merucry Deposition (Loading) in Water **L_T** **1.33** kg/yr

Equation 1-1 is based on Equation 5-29, pp. 5-64, Section 5.7.1.1 (Chapter 5), HHRAP by USEPA, September 2005 which simplifies to above equation assuming that all the atmospheric deposition will result in dissolved mercury in water bodies of the concerned watershed.

2. Concentration in Water and Fish

$$\boxed{C_{dw} = \frac{L_T}{Vf_x \times f_{wc} + k_{wt} \times A_w \times (d_{wc} + d_{bs})}}$$ **Eqn 2-1**

Equation 2-1 is based on equation 5-35,pp. 5-70, Section 5.7.4 (Chapter 5), HHRAP by USEPA, September 2005. k_{wt} is the total water body dissipation rate constant for Mercury (yr^{-1}), no dissipitation rate for mercury is assumed for conservative estimates (k_{wt} = 0), d_{wc} and d_{bs} represent the depth of the water column and benthic sediment respectively (m).

Applying Assumptions (k_{wt} =0) to Equation 2-1 which then reduces to Equation 2-2:

$$\boxed{C_{dw} = \frac{L_T}{Vf_x \times f_{wc}}}$$ **Eqn 2-2**

$$\boxed{C_{dw_{(MeHg)}} = C_{dw} \times \% \, MeHg}$$ **Eqn 2-3**

Table 2-1. Predicted Surface Water and Fish Concentrations

Parameter	Symbol	Value	Units
Total Concentration of Mercury in Water (Pee Dee River Basin, due to emissions from Pee Dee Facility)	C_{dw}	3.87E-02	ng/L
Total Concentration of methylmerucry in Water (Pee Dee River Basin, due to emissions from Pee Dee Facility)	$C_{dw(MeHg)}$	5.81E-03	ng/L
Total Concentration of methylmercury in Fish due to emissions from Pee Dee Facility[1]	$C_{fish(MeHg)}$	1.55E-02	mg/kg - fish tissue

[1]Total Methylmercury concentration in fish calculated using dissolved mercury water concentration from Table 2-1and the Bio-accumulation factor (BAF) from Table A-4.

3. Ingestion

$$\boxed{I_{fish_{(MeHg)}} = C_{fish_{(MeHg)}} \times CR_{fish} \times F_{fish}}$$ **Eqn 3-1**

Equation 3-1 is based on equation outlined in Table C-1-4 (Appendix C,) HHRAP by US EPA, September 2005.

Table 3-1. Ingestion Rates of Fish for Humans

Parameter	Symbol	Value		Units
		Fisher Adult	Fisher Child	
Daily Intake of Methylmercury from Fish to Humans (due to emissions from Pee Dee Facility)	$I_{fish\ (MeHg\text{-}PD)}$	3.37E-06	6.41E-06	mg/kg-day
Daily Intake of Methylmercury from Fish to Humans (due to median background mercury concentration)[1]	$I_{fish\ (MeHg\text{-}Median\ BG)}$	1.93E-04	3.68E-04	mg/kg-day
Daily Intake of Methylmercury from Fish to Humans (due to highest background mercury concentration)[2]	$I_{fish\ (MeHg\text{-}Highest\ BG)}$	1.52E-03	2.89E-03	mg/kg-day

[1]The Daily Intake of Methlymercury from Fish to Humans for Background concentration is calculated based on the median fish concentration (0.89 mg/kg-day) in the USEPA fish advisory database for the Little Pee Dee River.

[2]The Daily Intake of Methlymercury from Fish to Humans for Background concentration is calculated based on the highest fish concentration (7.0 mg/kg-day) in the USEPA fish advisory database for the Little Pee Dee River.

4. Risk Hazard[1]

$$HQ_{fish-ingestion} = \frac{I_{fish_{(MeHg)}} \times ED \times EF}{RfD \times AT \times 365}$$ **Eqn 4-1**

Equation 4-1 based on equation outlined in Table C-1-8 (Appendix C), HHRAP by USEPA, September 2005.

$$HI_{ingestion} = \sum_{All\ Sources} HQ_{ingestion}$$ **Eqn 4-2**

Equation 4-2 based on equation outlined in Table C-1-10 (Appendix C), HHRAP by USEPA, September 2005.

Table 4-1. Hazard Quotients and Hazard Indices (Ingestion)

Parameter	Value		Units	Hazard Quotient less than 1	
	Fisher Adult	Fisher Child		Fisher Adult	Fisher Child
Impact due to Emissions from Pee Dee Facility					
Hazard Quotient (Fish Ingestion)	0.03	0.06	Unitless	**YES**	**YES**
Impact due to Median Background Concentration					
Hazard Quotient[2] (Fish Ingestion, Background Concentration)	1.85	3.53	Unitless	**NO**	**NO**
Impact due to Highest Background Concentration					
Hazard Quotient[2] (Fish Ingestion, Background Concentration)	14.58	27.74	Unitless	**NO**	**NO**
Pee Dee Emissions as % contribution to cumulative HQ					
Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	**1.71%**	**1.71%**	-	-	-
Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	**0.22%**	**0.22%**	-	-	-

[1] *'The exposure from ingestion of marine fish comprised greater than 99.9 percent of the total exposure to methylmercury'* as per pp. 27, Sec 3.2.1.1 (Chapter 3), Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

[2]This Hazard Quotient is calculated based on the ingestion rate of the fish with median, highest methylmercury concentration (refer to Table 3-1) in the Pee Dee Region as outlined in Equation 4-1.

TABLE B-4-1
WATERSHED SOIL CONCENTRATION DUE TO DEPOSITION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$Cs_{tD} = \frac{Ds \times \left(1 - \exp(-ks \cdot tD)\right)}{ks}$$

$$Ds = \frac{100 \cdot Q'_{(Hg2+)}}{Z_s \cdot BD} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	**2.74E-05**	**5.58E-07**
SITE- AND CONTAMINANT-SPECIFIC	**% MeHg**[1]	%	98%	2%
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
CALC: B-4-1	**D_s**	mg/kg soil-yr	**9.13E-07**	**1.86E-08**
COPC AND SOURCE SPECIFIC	**$Dytwv_{ws}$**[3]	s/m2-yr	1.23E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{ws}$**[3]	s/m2-yr	1.03E-04	--
COPC SPECIFIC	**F_v**[4]	unitless	9.90E-01	--
CALC: B-1-2	**ks**	yr^{-1}	2.052E-05	1.72E-04
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[5]	g/s	2.30E-04	--
SITE SPECIFIC	**tD**[2]	yr	3.00E+01	3.00E+01
SITE SPECIFIC	**Z_s**[2]	m	2.00E+01	2.00E+01

[1]Divalent Mercury speciation split in soils is assumed 98% Hg2+ and 2% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Table B-4-1, Appendix B, p. B-170 and p. B-172, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over watershed from AERMOD Model Runs.

[4]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[5]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes contriburtion from both Boilers (2*57.8 lbs = 115.6 lbs/yr).

TABLE B-4-2
COPC SOIL LOSS CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ks = ksg + kse + ksr + ksl + ksv$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-2	**ks**	yr^{-1}	**2.05E-05**	**1.72E-04**
COPC-SPECIFIC	**ksg**[1]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-3	**kse**[2]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-4	**ksr**	yr^{-1}	1.73E-05	1.43E-04
CALC: B-4-5	**ksl**	yr^{-1}	3.22E-06	2.67E-05
CALC: B-1-6	**ksv**	yr^{-1}	3.86E-10	1.86E-06

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]HHRAP recommended kse default value of zero for mercuric chloride, and methylmercury. Table B-4-2, Appendix B, p. B-177, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-3
COPC LOSS CONSTANT DUE TO SOIL EROSION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$kse = \frac{0.1 \cdot X_e \cdot SD \cdot ER}{BD \cdot Z_s} \cdot \left(\frac{Kd_s \cdot BD}{\theta_{sw} + (Kd_s \cdot BD)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-3	**kse**[1]	yr^{-1}	**0.00E+00**	**0.00E+00**
CALC: B-4-13	$\mathbf{X_e}$	kg/m^2-yr	-	-
CALC: B-4-14	**SD**	unitless	-	-
COPC SPECIFIC	**ER**	unitless	-	-
SITE SPECIFIC	**BD**	g soil/cm^3 soil	-	-
SITE SPECIFIC	$\mathbf{Z_s}$	cm	-	-
COPC SPECIFIC	$\mathbf{Kd_s}$	cm^3 water/g soil	-	-
SITE SPECIFIC	**θsw**	mL/cm^3 soil	-	-

[1] Consistent with U.S. EPA (1994), U.S. EPA (1994b), and NC DEHNR (1997), the HHRAP recommends that the default value assumed for kse is zero because contaminated soil erodes both onto the site and away from the site. Uncertainty may overestimate kse. Table B-4-3, Appendix B, p. B-180, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-4
COPC LOSS CONSTANT DUE TO RUNOFF
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksr = \frac{RO}{\theta_{sw} \cdot Z_s} \cdot \left(\frac{1}{1 + \left(Kd_s \cdot BD / \theta_{sw} \right)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-4	**ksr**	yr^{-1}	**1.73E-05**	**1.43E-04**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	**Z_s**[3]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]Table B-4-4, pp. B-186 and B-187, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Assumed Tilled soil, value based on Table B-4-4, pp. B-186, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-5
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksl = \frac{P + I - OR - E_v}{\theta_{sw} \cdot Z_s \cdot \left[1.0 + \left(BD \cdot Kd_s / \theta_{sw}\right)\right]}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-5	**ksl**	yr^{-1}	**3.22E-06**	**2.67E-05**
SITE SPECIFIC	**P**[1]	cm/yr	1.14E+02	1.14E+02
SITE SPECIFIC	**I**[2]	cm/yr	2.00E+01	2.00E+01
SITE SPECIFIC	**RO**[3]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	E_v[4]	cm/yr	9.83E+01	9.83E+01
SITE SPECIFIC	θ_{sw}[5]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	Z_s[5]	cm	2.00E+01	2.00E+01
SITE SPECIFIC	**BD**[5]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	Kd_s[6]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Monthly Stations Normals of Temperature, Precipitation and Heating and Cooling Degree Days (1971-2000) for South Carolina by National Oceanic and Atmospheric Administration (Feburary 2002), the Florence RGNL AP Site was chosen (closest to Pee Dee Facility).

[2]Value derived using 2003 National Resources Inventory (NRI) -Annual Irrigation Input for Model Simulations. Value represents geospatial average across Pee Dee Watershed. (ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/croplandreport)

[3]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[4]Amatya, D. M., Trettin, C. 2007. Annual evapotranspiration of a forested wetland watershed, SC at ASABE Annual International Meeting, June 17 - 20, 2007, p. 16. (URL: http://asae.frymulti.com/abstract.asp?aid=22992&t=2)

[5]Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[6]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-6
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksv = \left[\frac{3.1536 \times 10^{7} \cdot H}{Z_s \cdot Kd_s \cdot R \cdot T_a \cdot BD}\right] \cdot \left(\frac{D_a}{Z_s}\right) \cdot \left[1 - \left(\frac{BD}{\rho_{soil}}\right) - \theta_{sw}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-6	**ksv**	yr^{-1}	**3.86E-10**	**1.86E-06**
COPC SPECIFIC	**H**[1]	$atm\text{-}m^3/mol$	7.10E-10	4.70E-07
SITE SPECIFIC	$\mathbf{Z_s}$[2]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	$\mathbf{Kd_s}$[1]	cm^3 water/g soil	5.80E+04	7.00E+03
CONSTANT	**R**[2]	$atm\text{-}m^3/mol\text{-}K$	8.21E-05	8.21E-05
SITE SPECIFIC	$\mathbf{T_a}$[2]	K	2.98E+02	2.98E+02
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	$\mathbf{D_a}$[1]	cm^2/s	6.00E-02	5.28E-02
SITE SPECIFIC	$\boldsymbol{\rho_{soil}}$[2]	g/cm^3	2.70E+00	2.70E+00
SITE SPECIFIC	$\boldsymbol{\theta_{sw}}$[2]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table B-4-6, pp. B-195, B-196 and B-197, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-7
TOTAL WATER BODY LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_T = L_{DEP} + L_{dif} + L_{RI} + L_R + L_E + L_{Dis}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-7	$\mathbf{L_T}$	g/yr	**2.85E+01**	--
CALC: B-4-8	$\mathbf{L_{DEP}}$	g/yr	7.58E+00	--
CALC: B-4-12	$\mathbf{L_{dif}}$	g/yr	2.43E-01	--
CALC: B-4-9	$\mathbf{L_{RI}}$	g/yr	1.09E+01	--
CALC: B-4-10	$\mathbf{L_R}$	g/yr	5.51E-01	--
CALC: B-4-11	$\mathbf{L_E}$	g/yr	9.24E+00	--
Wastewater Discharges	$\mathbf{L_{Dis}}$[1]	g/yr	3.93E-01	--

[1]$L_{Dis} = C_{Dis} \times V_{Dis}$. Where, C_{Dis} (concentration of mercury in wastewater discharges) and V_{Dis} (proposed volumetric flow rate of the wastewater discharges). C_{Dis} and V_{Dis} have been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper. Original HHRAP equation modified to include the additional loading term $L_{DIS.}$

TABLE B-4-8
DEPOSITION TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L'_{DEP} = Q'_{(Hg2+)} \cdot \left[F_v \cdot Dytwv_{wb} + (1 - F_v) \cdot Dytwp_{wb} \right] \cdot A_w$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-8	**L'_{DEP}**	g/yr	**7.58E+00**	**--**
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$[1]**	g/s	2.30E-04	**--**
COPC SPECIFIC	**F_v[2]**	unitless	9.90E-01	**--**
COPC AND SOURCE SPECIFIC	**$Dytwv_{wb}$[3]**	s/m^2-yr	1.85E-03	**--**
COPC AND SOURCE SPECIFIC	**$Dytwp_{wb}$[3]**	s/m^2-yr	1.42E-04	**--**
SITE SPECIFIC	**A_w[4]**	m^2	1.80E+07	**--**

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{wb}$) and particle bound ($Dytwp_{wb}$) deposition over waterbody from AERMOD Model Runs.

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-9
IMPERVIOUS RUNOFF LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{RI} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{ws} + (1 - F_v) \cdot Dytwp_{ws}\right] \cdot A_I$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-9	$\mathbf{L_{RI}}$	g/yr	**1.09E+01**	--
COPC AND SOURCE SPECIFIC	$\mathbf{Q'_{(Hg2+)}}$ [1]	g/s	2.30E-04	--
COPC SPECIFIC	$\mathbf{F_v}$ [2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwv_{ws}}$ [3]	s/m^2-yr	1.23E-03	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwp_{ws}}$ [3]	s/m^2-yr	1.03E-04	--
SITE SPECIFIC	$\mathbf{A_I}$ [4]	m^2	3.91E+07	--

[1]Total Mercury Emissions from 2 Boilers (2*57.8 lbs = 115.6 lbs/yr), which includes the loss to global cycle.
[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.
[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over waterbody from AERMOD Model Runs.
[4]A_I, impervious surface area of watershed, calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

TABLE B-4-10
PERVIOUS RUNOFF LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_R = RO \cdot (A_L - A_I) \cdot \frac{Cs \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.01$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-10	**L_R**	g/yr	**5.505E-01**	**9.29E-02**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**A_L**[2]	m^2	3.91E+09	3.91E+09
SITE SPECIFIC	**A_I**[3]	m^2	3.91E+07	3.91E+07
CALC: B-4-1	**CstD**	mg/kg soil	2.74E-05	5.58E-07
SITE SPECIFIC	**BD**[4]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[4]	mL/cm^3 soil	2.00E-01	2.00E-01
COPC SPECIFIC	**Kd_s**[5]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[3]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

[4]Table B-4-10, p. B-208, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-11
EROSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_E = X_e \cdot (A_L - A_I) \cdot SD \cdot ER \cdot \frac{Cs \cdot Kd_s \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.001$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-11	**L_E**	g/yr	**9.24E+00**	**1.88E-01**
CALC: B-4-13	**X_e**	kg soil /m^2-yr	2.29E+00	2.29E+00
SITE SPECIFIC	**A_L**[1]	m^2	3.91E+09	3.91E+09
SITE SPECIFIC	**A_I**[2]	m^2	3.91E+07	3.91E+07
CALC: B-4-14	**SD**	unitless	3.79E-02	3.79E-02
SITE SPECIFIC	**ER**[3]	unitless	1.00E+00	1.00E+00
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	2.74E-05	5.58E-07
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[3]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[3]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).
[2]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.
[3]Table B-4-11, p. B-212, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.
[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-12
DIFFUSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{dif} = \frac{K_v \times Q'_{(Hg\,2+)} \times F_v \times Cyvw_{wb} \times A_w \times 1 \times 10^{-6}}{\dfrac{H}{R \times T_{wk}}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-12	**Ldif**	g/yr	**2.43E-01**	--
CALC: B-4-19	**K_v**	m/yr	1.21E-03	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$[1]**	g/s	2.30E-04	--
COPC SPECIFIC	**F_v[2]**	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Cywv_{wb}$[3]**	µg-s/g-m^3	1.43E-03	--
SITE SPECIFIC	**A_w[4]**	m^2	1.80E+07	--
COPC SPECIFIC	**H[5]**	atm-m^3/mol	7.10E-10	--
CONSTANT	**R[6]**	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	**T_{wk}[6]**	K	2.98E+02	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Yearly average air concentration from vapor phase (Cywv) over waterbody from AERMOD modeling runs

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[6]Table B-4-12, p. B-217, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-13
UNIVERSAL SOIL LOSS EQUATION (USLE)
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$X_e = RF \cdot K \cdot LS \cdot C \cdot PF \cdot \frac{907.18}{4047}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-13	**X_e**	kg/m^2-yr	**2.29E+00**	--
SITE SPECIFIC	**RF**[1]	yr^{-1}	1.75E+02	--
SITE SPECIFIC	**K**[2]	ton/acre	3.90E-01	--
SITE SPECIFIC	**LS**[2]	unitless	1.50E+00	--
SITE SPECIFIC	**C**[2]	unitless	1.00E-01	--
SITE SPECIFIC	**PF**[2]	unitless	1.00E+00	--

[1]USLE Rainfall Erosivity Factor - median of HHRAP recommended defaut range between 50-300.

[2]Table B-4-13, pp. B-219 and B-220, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-14
SEDIMENT DELIVERY RATIO
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$SD = a \cdot (A_L)^{-b}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-14	**SD**	unitless	**3.79E-02**	**--**
SITE SPECIFIC	**a**[1]	unitless	6.00E-01	**--**
SITE SPECIFIC	**A_L**[2]	m^2	3.91E+09	**--**
SITE SPECIFIC	**b**[1]	unitless	1.25E-01	**--**

[1]Table B-4-14, pp. B-223 and B-224, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-15
TOTAL WATER BODY CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C'_{wtot} = \frac{L'_T}{\left(Vf'_x + V_{Dis}\right) \times f_{wc} + k_{wt} \times A_w \times \left(d_{wc} + d_{bs}\right)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-15	**C'_{wtot}**	g/m^3 (mg/L)	**1.09E-06**	--
CALC: B-4-7	**L'_T**	g/yr	2.85E+01	--
SITE SPECIFIC	**Vf'_x**[1]	m^3/yr	1.35E+09	--
SITE SPECIFIC	**V_{Dis}**[2]	m^3/yr	3.93E+06	
CALC: B-4-16	**f_{wc}**	unitless	3.49E-03	--
CALC: B-4-17	**k_{wt}**	yr^{-1}	5.89E-01	--
SITE SPECIFIC	**A_w**[3]	m^2	1.80E+07	--
SITE SPECIFIC	**d_{wc}**[4]	m	2.00E+00	--
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	--

[1]Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[2]V_{Dis}, proposed volumetric flow rate of the wastewater discharges and has been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper.

[3]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[4]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroelectric Project, FERC NO. 2206, Water Resources Work Group (April 30, 2004).

[5]Table B-4-15, p. B-228, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-16
FRACTION IN WATER COLUMN AND BENTHIC SEDIMENT (CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$f_{wc} = \frac{(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}) \cdot d_{wc}/d_z}{(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}) \cdot d_{wc}/d_z + (\theta_{bs} + Kd_{bs} \cdot C_{BS}) \cdot d_{bs}/d_z}$$

$$f_{bs} = 1 - f_{wc}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-16	**f_{wc}**	unitless	**3.49E-03**	--
CALC: B-4-16	**f_{bs}**	unitless	**9.97E-01**	--
COPC SPECIFIC	**Kd_{sw}**[1]	L/kg SS	1.00E+05	--
SITE SPECIFIC	**TSS**[2]	mg/L	1.63E+01	--
SITE SPECIFIC	**d_{wc}**[3]	m	2.00E+00	--
SITE SPECIFIC	**d_z**[4]	m	2.03E+00	--
SITE SPECIFIC	**θ_{bs}**[5]	unitless	6.00E-01	--
COPC SPECIFIC	**Kd_{bs}**[1]	L / kg BS	5.00E+04	--
SITE SPECIFIC	**C_{BS}**[5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[3]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[4]d_z (Total water body depth) = d_{bs} + d_{wc}.

[5]Table B-4-16, pp. B-232 and B-233, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-17
OVERALL TOTAL WATER BODY DISSIPATION RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_{wt} = f_{wc} \cdot k_v + f_{bs} \cdot k_b$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-17	k_{wt}	yr^{-1}	**5.89E-01**	--
CALC: B-4-16	f_{wc}	unitless	3.49E-03	--
CALC: B-4-18	k_v	yr^{-1}	2.26E-04	--
CALC: B-4-16	f_{bs}	unitless	9.97E-01	--
CALC: B-4-22	k_b	yr^{-1}	5.91E-01	--

TABLE B-4-18
WATER COLUMN VOLATILIZATION LOSS RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_v = \frac{K_v}{d_z \cdot (1 + Kd_{sw} \cdot TSS \cdot 10^{-6})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-18	$\mathbf{k_v}$	yr^{-1}	**2.257E-04**	--
CALC: B-4-19	$\mathbf{K_v}$	m/yr	1.21E-03	--
SITE SPECIFIC	$\mathbf{d_z}$[1]	m	2.03E+00	--
COPC SPECIFIC	$\mathbf{Kd_{sw}}$[2]	m	1.00E+05	--
SITE SPECIFIC	**TSS**[3]	m	1.63E+01	--

[1] d_z (Total water body depth) = d_{bs} + $d_{wc.}$
[2] Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[3] Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-19
OVERALL COPC TRANSFER RATE COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$K_v = \left[K_L^{-1} + \left(K_G \cdot \frac{H}{R \cdot T_{wk}} \right)^{-1} \right]^{-1} \cdot \theta^{(T_{wk} - 293)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-19	$\mathbf{K_v}$	m/yr	**1.21E-03**	--
CALC: B-4-20	$\mathbf{K_{L(river)}}$	m/yr	2.83E+02	--
CALC: B-4-21	$\mathbf{K_{G(river)}}$	m/yr	3.65E+04	--
COPC SPECIFIC	**H**[1]	atm-m^3/mol	7.10E-10	--
CONSTANT	**R**[2]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	$\mathbf{T_{wk}}$[2]	K	2.98E+02	--
SITE SPECIFIC	**θ**[2]	unitless	1.03E+00	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table B-4-19, p. B-243, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-20
LIQUID PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_L = \sqrt{\frac{(1 \times 10^{-4}) \cdot D_w \cdot u}{d_z}} \cdot 3.1536 \times 10^7$$

For Quiescent Lakes or Ponds

$$K_L = (C_d^{0.5} \cdot W) \cdot (\frac{\rho_a}{\rho_w})^{0.5} \cdot \frac{k^{0.33}}{\lambda_z} \cdot (\frac{\mu_w}{\rho_w \cdot D_w})^{-0.67} \cdot 3.1536 \times 10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-20	**K_L(river)**	m/yr	**2.83E+02**	--
CALC: B-4-20	**K_L(pond)**	m/yr	**1.17E+02**	--
COPC SPECIFIC	D_w[1]	cm^2/s	5.25E-06	--
SITE SPECIFIC	u[2]	m/s	3.11E-01	--
SITE SPECIFIC	d_z[3]	m	2.03E+00	--
SITE SPECIFIC	C_d[4]	unitless	1.10E-03	--
SITE SPECIFIC	W[4]	m/s	3.90E+00	--
SITE SPECIFIC	ρ_a[4]	g/cm^3	1.20E-03	--
SITE SPECIFIC	ρ_w[4]	g/cm^3	1.00E+00	--
CONSTANT	k[4]	unitless	4.00E-01	--
SITE SPECIFIC	λ_z[4]	unitless	4.00E+00	--
CONSTANT	μ_w[4]	g/cm-s	1.69E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Stream Velocity data (60 Day Average, Sep 15 - Nov 14) for USGS 02135200 Pee Dee River AT Hwy 701 NR Bucksport, SC (URL: www.waterdata.usgs.gov).

[3]d_z (Total water body depth) = d_{bs} + $d_{wc.}$

[4]Table B-4-20, pp. B-246 and B-247, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-21
GAS PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_G = 36500 \ m/yr$$

For Quiescent Lakes or Ponds

$$K_G = (C_d^{0.5} \cdot W) \cdot \frac{k^{0.33}}{\lambda_z} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot 3.1536\times10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-21	K_G(river)[1]	m/yr	**3.65E+04**	--
CALC: B-4-21	K_G(pond)	m/yr	4.06E+05	--
SITE SPECIFIC	C_d[1]	unitless	1.10E-03	--
SITE SPECIFIC	W[1]	m/s	3.90E+00	--
CONSTANT	k[1]	unitless	4.00E-01	--
SITE SPECIFIC	λ_z[1]	unitless	4.00E+00	--
SITE SPECIFIC	μ_a[1]	g/cm-s	1.81E-04	--
SITE SPECIFIC	ρ_a[1]	g/cm^3	1.20E-03	--
COPC SPECIFIC	D_a[2]	cm^2/s	6.00E-02	--

[1]Table B-4-21, pp. B-249 and B-250, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005
[2]Table 7, Section 6.5, Page 28, Deposition Parameterizations for the Industrial Source Complex (ISC3) June 2002.

TABLE B-4-22
BENTHIC BURIAL RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_b = \left(\frac{X_e \cdot A_L \cdot SD \cdot 1\times10^3 - Vf_x \cdot TSS}{A_w \cdot TSS} \right) \cdot \left(\frac{TSS \cdot 1\times10^{-6}}{C_{BS} \cdot d_{bs}} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-22	**k_b**	yr^{-1}	**5.908E-01**	--
CALC: B-4-13	**X_e**	kg/m^2-yr	2.29E+00	--
SITE SPECIFIC	**A_L**[1]	m^2	3.91E+09	--
CALC: B-4-14	**SD**	unitless	3.79E-02	--
SITE SPECIFIC	**Vf'_x**[2]	m^3/yr	1.35E+09	--
SITE SPECIFIC	**TSS**[3]	mg/L	1.63E+01	--
SITE SPECIFIC	**A_w**[4]	m^2	1.80E+07	--
SITE SPECIFIC	**C_{BS}**[5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	--

[1] A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[2] Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[3] Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[4] A_w, Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5] Table B-4-22, p. B-255, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-23
TOTAL WATER COLUMN CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{wctot} = f_{wc} \cdot C_{wtot} \cdot \frac{d_{wc} + d_{bs}}{d_{wc}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-23	**C_{wctot}**	mg/L	**3.864E-09**	**--**
CALC: B-4-16	**f_{wc}**	unitless	3.49E-03	**--**
CALC: B-4-15	**C_{wtot}**	mg/L	1.09E-06	**--**
SITE SPECIFIC	**d_{wc}**[1]	m	2.00E+00	**--**
SITE SPECIFIC	**d_{bs}**[2]	m	3.00E-02	**--**

[1]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[2]Table B-4-23, p. B-258, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-24
DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{dw} = \frac{C_{wctot}}{1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	mg/L	**1.25E-09**	**2.20E-10**
COPC SPECIFIC	**% MeHg**[1]	%	85.00%	15.00%
CALC: B-4-23	C_{wctot}	mg/L	3.86E-09	--
COPC SPECIFIC	Kd_{sw}[2]	L/kg SS	1.00E+05	--
SITE SPECIFIC	**TSS**[3]	mg/L	1.63E+01	--

[1]Divalent Mercury speciation split in the water body is assumed 85% Hg^{2+} and 15% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-27

FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION

(CONSUMPTION OF FISH EQUATIONS)

$$C_{fish} = C_{dw} \cdot BAF_{fish}$$

Concentration in fish based on the Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg fish tissue	**5.88E-04**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	mg/L	2.20E-10
COPC SPECIFIC	BAF_{fish}[1]	L/kg fish tissue	2.67E+06

[1]Table 1, Section 3.1.3.1.3, p. 21.,Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Median and Highest Background Concentration in Fish

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
SITE SPECIFIC	$C_{fish(median)}$[1]	mg/kg fish tissue	**8.90E-01**
SITE SPECIFIC	$C_{fish(highest)}$[1]	mg/kg fish tissue	**7.00E+00**

[1]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE B-5-1
AIR CONCENTRATION
(DIRECT INHALATION EQUATION)

$$C_a = Q_{(Hg0)} \cdot \left[Cyv F_v + (1 - F_v) \cdot Cyp \right]$$

For Elemental Mercury, F_v = 1.0, therefore:

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v \right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: B-5-1	C_a	μg/m^3	**1.52E-07**
SOURCE AND COPC SPECIFIC	$Q_{(Hg0)}$[1]	g/s	1.33E-05
COPC SPECIFIC	F_v[2]	unitless	1.00E+00
COPC AND SOURCE SPECIFIC	Cyv[3]	μg-s/g-m^3	1.14E-02

[1]Q(Hg0) = Q (total mercury) * 0.8% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2 of mercury deposition and risk assessment report.

[3]Unitized yearly air concentration from vapor phase from AERMOD Runs.

TABLE C-1-4
COPC INTAKE FROM FISH

$$I_{fish} = C_{fish} \cdot CR_{fish} \cdot F_{fish}$$

Intake Based on Proposed Pee Dee Facility Emissions

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	**1.28E-07**
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg	5.88E-04
EXPOSURE PARAMETER	$CR_{fish(fisher\ adult)}$[1]	kg/kg fish tissue-day	2.17E-04
SITE SPECIFIC	F_{fish}[2]	unitless	1.00E+00

[1]Based on Total Fish Consumption for the South Atlantic Region (Table 10-1, Appendix 10A, Exposure Factors Handbook by USEPA, August 1997) for an adult (15.2 g/adult) with an average body weight of adult as 70 kg (Table C-1-5, Appendix C, HHRAP by USEPS, September 2005).

[2]F_{fish} - Fraction of fish that is contaminated, Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Intake Based on Median Background Concentration in Pee Dee River[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	**1.93E-04**
SITE SPECIFIC	$C_{fish(median)}$[2]	mg/kg	8.90E-01

[1]I_{fish}, based on Fisher Adult consumption rate and F_{fish} = 1.0.

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

Intake Based on Highest Background Concentration in Pee Dee River[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	**1.52E-03**
SITE SPECIFIC	$C_{fish(highest)}$[2]	mg/kg	7.00E+00

[1]I_{fish}, based on Fisher Adult consumption rate and F_{fish} = 1.0.

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE C-1-5
COPC INTAKE FROM DRINKING WATER

$$I_{dw} = \frac{C_{dw} \cdot CR_{dw} \cdot F_{dw}}{BW}$$

TYPE	COPC CAS NO. PARAMETERS	Methyl Mercury 22967-92-6
CALC: C-1-5	$I_{dw(Pee\ Dee)}$	**4.41E-12**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	2.20E-10
EXPOSURE PARAMETER	CR_{dw}[1]	1.40E+00
SITE SPECIFIC	F_{dw}[1]	1.00E+00
EXPOSURE PARAMETER	BW[1]	7.00E+01

[1]Table C-1-5, p. C-18, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE C-1-6
TOTAL DAILY INTAKE

$$I = I_{soil} + I_{ag} + I_{beef} + I_{milk} + I_{fish} + I_{pork} + I_{poultry} + I_{eggs} + I_{dw}$$

Intake Based on Emissions from Proposed Pee Dee Facility[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(Pee\ Dee)}$	mg/kg-day	**1.28E-07**
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	1.28E-07
CALC: C-1-5	I_{dw}[1]	mg/kg-day	4.41E-12

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Median Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(median)}$	mg/kg-day	**1.93E-04**
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	1.93E-04

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Highest Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(highest)}$	mg/kg-day	**1.52E-03**
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	1.52E-03

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

TABLE C-1-8
HAZARD QUOTIENT (INDEX) : NONCARCINOGENS[1]

$$HQ = \frac{I \cdot ED \cdot EF}{RfD \cdot AT \cdot 365}$$

[1]The Hazard Index (HI) is equal to Hazard Quotient (HQ) since methlymercury is the only COPC for which an HQ is calculated.

Impact Based on Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{\text{fisher adult (Pee Dee)}}$**	unitless	**1.22E-03**
CALC: C-1-6	**$I_{\text{(Pee Dee)}}$**	mg/kg-day	1.28E-07
EXPOSURE PARAMETER	**ED**[1]	yr	30
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Median Background Concentration in Great Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{\text{fisher adult (median)}}$**	unitless	**1.85**
CALC: C-1-6	**$I_{\text{(median)}}$**	mg/kg-day	1.93E-04
EXPOSURE PARAMETER	**ED**[1]	yr	30
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Highest Background Concentration in Great Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{\text{fisher adult (highest)}}$**	unitless	**14.57**
CALC: C-1-6	**$I_{\text{(highest)}}$**	mg/kg-day	1.52E-03
EXPOSURE PARAMETER	**ED**[1]	yr	30
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

CUMULATIVE HAZARD QUOTIENT (INDEX): NONCARCINOGENS

Fisher Adult Scenario

TYPE	SOURCE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
INDIVIDUAL	Proposed Pee Dee Facility Emissions	$HQ_{fisher\ adult\ (Pee\ Dee)}$	unitless	1.22E-03
	Median Background Concentration	$HQ_{fisher\ adult\ (median)}$	unitless	1.85
	Highest Background Concentration	$HQ_{fisher\ adult\ (highest)}$	unitless	14.57
% CONTRIBUTION	Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	%	unitless	0.07%
	Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	%	unitless	0.01%

TABLE C-2-2
INHALATION HAZARD QUOTIENT

$$HQ_{inh(i)} = \frac{EC * 0.001}{RfC}$$

$$EC = \frac{C_a \cdot EF \cdot ED}{AT \cdot 365\ days/year}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: C-1-5	**$HQ_{(inh)}$**	unitless	**1.32E-07**
CALC: C-1-5	**EC**	$\mu g/m^3$	1.46E-07
EXPOSURE PARAMETER	**RfC[1]**	mg/m^3	1.10E-03
CALC: B-5-1	**C_a**	$\mu g/m^3$	1.52E-07
SITE SPECIFIC	**EF[2]**	days/yr	3.50E+02
EXPOSURE PARAMETER	**ED[2]**	yr	3.00E+01
EXPOSURE PARAMETER	**AT[2]**	yr	3.00E+01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table C-2-2, pp. C-37 and C-38, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-1
WATERSHED SOIL CONCENTRATION DUE TO DEPOSITION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$Cs_{tD} = \frac{Ds \times \left(1 - \exp(-ks \cdot tD)\right)}{ks}$$

$$Ds = \frac{100 \cdot Q'_{(Hg2+)}}{Z_s \cdot BD} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	**2.74E-05**	**5.58E-07**
SITE- AND CONTAMINANT-SPECIFIC	**% MeHg**[1]	%	98%	2%
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
CALC: B-4-1	**D_s**	mg/kg soil-yr	**9.13E-07**	**1.86E-08**
COPC AND SOURCE SPECIFIC	**$Dytwv_{ws}$**[3]	s/m2-yr	1.23E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{ws}$**[3]	s/m2-yr	1.03E-04	--
COPC SPECIFIC	**F_v**[4]	unitless	9.90E-01	--
CALC: B-1-2	**ks**	yr^{-1}	2.052E-05	1.72E-04
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[5]	g/s	2.30E-04	--
SITE SPECIFIC	**tD**[2]	yr	3.00E+01	3.00E+01
SITE SPECIFIC	**Z_s**[2]	m	2.00E+01	2.00E+01

[1]Divalent Mercury speciation split in soils is assumed 98% Hg2+ and 2% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Table B-4-1, Appendix B, p. B-170 and p. B-172, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over watershed from AERMOD Model Runs.

[4]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[5]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes contriburtion from both Boilers (2*57.8 lbs = 115.6 lbs/yr).

TABLE B-4-2
COPC SOIL LOSS CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ks = ksg + kse + ksr + ksl + ksv$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-2	**ks**	yr^{-1}	**2.05E-05**	**1.72E-04**
COPC-SPECIFIC	**ksg**[1]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-3	**kse**[2]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-4	**ksr**	yr^{-1}	1.73E-05	1.43E-04
CALC: B-4-5	**ksl**	yr^{-1}	3.22E-06	2.67E-05
CALC: B-1-6	**ksv**	yr^{-1}	3.86E-10	1.86E-06

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]HHRAP recommended kse default value of zero for mercuric chloride, and methylmercury. Table B-4-2, Appendix B, p. B-177, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-3
COPC LOSS CONSTANT DUE TO SOIL EROSION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$kse = \frac{0.1 \cdot X_e \cdot SD \cdot ER}{BD \cdot Z_s} \cdot \left(\frac{Kd_s \cdot BD}{\theta_{sw} + (Kd_s \cdot BD)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-3	**kse**[1]	yr^{-1}	**0.00E+00**	**0.00E+00**
CALC: B-4-13	**X_e**	kg/m^2-yr	-	-
CALC: B-4-14	**SD**	unitless	-	-
COPC SPECIFIC	**ER**	unitless	-	-
SITE SPECIFIC	**BD**	g soil/cm^3 soil	-	-
SITE SPECIFIC	**Z_s**	cm	-	-
COPC SPECIFIC	**Kd_s**	cm^3 water/g soil	-	-
SITE SPECIFIC	**θsw**	mL/cm^3 soil	-	-

[1] Consistent with U.S. EPA (1994), U.S. EPA (1994b), and NC DEHNR (1997), the HHRAP recommends that the default value assumed for kse is zero because contaminated soil erodes both onto the site and away from the site. Uncertainty may overestimate kse. Table B-4-3, Appendix B, p. B-180, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-4
COPC LOSS CONSTANT DUE TO RUNOFF
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksr = \frac{RO}{\theta_{sw} \cdot Z_s} \cdot \left(\frac{1}{1 + \left(Kd_s \cdot BD / \theta_{sw} \right)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-4	**ksr**	yr^{-1}	**1.73E-05**	**1.43E-04**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	**Z_s**[3]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]Table B-4-4, pp. B-186 and B-187, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Assumed Tilled soil, value based on Table B-4-4, pp. B-186, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-5
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksl = \frac{P + I - OR - E_v}{\theta_{sw} \cdot Z_s \cdot \left[1.0 + \left(BD \cdot Kd_s / \theta_{sw}\right)\right]}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-5	**ksl**	yr^{-1}	**3.22E-06**	**2.67E-05**
SITE SPECIFIC	**P**[1]	cm/yr	1.14E+02	1.14E+02
SITE SPECIFIC	**I**[2]	cm/yr	2.00E+01	2.00E+01
SITE SPECIFIC	**RO**[3]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	$\mathbf{E_v}$[4]	cm/yr	9.83E+01	9.83E+01
SITE SPECIFIC	$\boldsymbol{\theta_{sw}}$[5]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	$\mathbf{Z_s}$[5]	cm	2.00E+01	2.00E+01
SITE SPECIFIC	**BD**[5]	g $soil/cm^3$ soil	1.50E+00	1.50E+00
COPC SPECIFIC	$\mathbf{Kd_s}$[6]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Monthly Stations Normals of Temperature, Precipitation and Heating and Cooling Degree Days (1971-2000) for South Carolina by Nationa Oceanic and Atmospheric Administration (Feburary 2002), the Florence RGNL AP Site was chosen (closest to Pee Dee Facility).

[2]Value derived using 2003 National Resources Inventory (NRI) -Annual Irrigation Input for Model Simulations. Value represents geospatial average across Pee Dee Watershed. (ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/croplandreport)

[3]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[4]Amatya, D. M., Trettin, C. 2007. Annual evapotranspiration of a forested wetland watershed, SC at ASABE Annual International Meeting, June 17 - 20, 2007, p. 16. (URL: http://asae.frymulti.com/abstract.asp?aid=22992&t=2)

[5]Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[6]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-6
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksv = \left[\frac{3.1536 \times 10^7 \cdot H}{Z_s \cdot Kd_s \cdot R \cdot T_a \cdot BD}\right] \cdot \left(\frac{D_a}{Z_s}\right) \cdot \left[1 - \left(\frac{BD}{\rho_{soil}}\right) - \theta_{sw}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-6	**ksv**	yr^{-1}	**3.86E-10**	**1.86E-06**
COPC SPECIFIC	**H**[1]	atm-m^3/mol	7.10E-10	4.70E-07
SITE SPECIFIC	**Z_s**[2]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[1]	cm^3 water/g soil	5.80E+04	7.00E+03
CONSTANT	**R**[2]	atm-m^3/mol-K	8.21E-05	8.21E-05
SITE SPECIFIC	**T_a**[2]	K	2.98E+02	2.98E+02
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	**D_a**[1]	cm^2/s	6.00E-02	5.28E-02
SITE SPECIFIC	**ρ_{soil}**[2]	g/cm^3	2.70E+00	2.70E+00
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table B-4-6, pp. B-195, B-196 and B-197, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-7
TOTAL WATER BODY LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_T = L_{DEP} + L_{dif} + L_{RI} + L_R + L_E + L_{Dis}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-7	**L_T**	g/yr	**2.85E+01**	**--**
CALC: B-4-8	**L_{DEP}**	g/yr	7.58E+00	**--**
CALC: B-4-12	**L_{dif}**	g/yr	2.43E-01	**--**
CALC: B-4-9	**L_{RI}**	g/yr	1.09E+01	**--**
CALC: B-4-10	**L_R**	g/yr	5.51E-01	**--**
CALC: B-4-11	**L_E**	g/yr	9.24E+00	**--**
Wastewater Discharges	**L_{Dis}**[1]	g/yr	3.93E-01	**--**

[1]$L_{Dis} = C_{Dis} \times V_{Dis}$. Where, C_{Dis} (concentration of mercury in wastewater discharges) and V_{Dis} (proposed volumetric flow rate of the wastewater discharges). C_{Dis} and V_{Dis} have been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper. Original HHRAP equation modified to include the additional loading term L_{DIS}.

TABLE B-4-8
DEPOSITION TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L'_{DEP} = Q'_{(Hg2+)} \cdot \left[F_v \cdot Dytwv_{wb} + \left(1 - F_v\right) \cdot Dytwp_{wb}\right] \cdot A_w$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-8	**L'_{DEP}**	g/yr	**7.58E+00**	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[1]	g/s	2.30E-04	--
COPC SPECIFIC	**F_v**[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Dytwv_{wb}$**[3]	s/m^2-yr	1.85E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{wb}$**[3]	s/m^2-yr	1.42E-04	--
SITE SPECIFIC	**A_w**[4]	m^2	1.80E+07	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{wb}$) and particle bound ($Dytwp_{wb}$) deposition over waterbody from AERMOD Model Runs.

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-9
IMPERVIOUS RUNOFF LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{RI} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{ws} + (1 - F_v) \cdot Dytwp_{ws} \right] \cdot A_I$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-9	**L_{RI}**	g/yr	**1.09E+01**	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[1]	g/s	2.30E-04	--
COPC SPECIFIC	**F_v**[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Dytwv_{ws}$**[3]	s/m^2-yr	1.23E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{ws}$**[3]	s/m^2-yr	1.03E-04	--
SITE SPECIFIC	**A_I**[4]	m^2	3.91E+07	--

[1]Total Mercury Emissions from 2 Boilers (2*57.8 lbs = 115.6 lbs/yr), which includes the loss to global cycle.

[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over waterbody from AERMOD Model Runs.

[4]A_I, impervious surface area of watershed, calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

TABLE B-4-10
PERVIOUS RUNOFF LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_R = RO \cdot (A_L - A_I) \cdot \frac{Cs \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.01$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-10	L_R	g/yr	**5.505E-01**	**9.29E-02**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	A_L[2]	m^2	3.91E+09	3.91E+09
SITE SPECIFIC	A_I[3]	m^2	3.91E+07	3.91E+07
CALC: B-4-1	**CstD**	mg/kg soil	2.74E-05	5.58E-07
SITE SPECIFIC	**BD**[4]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	θ_{sw}[4]	mL/cm^3 soil	2.00E-01	2.00E-01
COPC SPECIFIC	Kd_s[5]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[3]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

[4]Table B-4-10, p. B-208, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-11
EROSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_E = X_e \cdot (A_L - A_I) \cdot SD \cdot ER \cdot \frac{Cs \cdot Kd_s \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.001$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-11	L_E	g/yr	**9.24E+00**	**1.88E-01**
CALC: B-4-13	X_e	kg soil /m^2-yr	2.29E+00	2.29E+00
SITE SPECIFIC	A_L[1]	m^2	3.91E+09	3.91E+09
SITE SPECIFIC	A_I[2]	m^2	3.91E+07	3.91E+07
CALC: B-4-14	**SD**	unitless	3.79E-02	3.79E-02
SITE SPECIFIC	**ER**[3]	unitless	1.00E+00	1.00E+00
CALC: B-4-1	Cs_{tD}	mg/kg soil	2.74E-05	5.58E-07
COPC SPECIFIC	Kd_s[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[3]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	θ_{sw}[3]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).
[2]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.
[3]Table B-4-11, p. B-212, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.
[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-12
DIFFUSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{dif} = \frac{K_v \times Q'_{(Hg\,2+)} \times F_v \times Cyvw_{wb} \times A_w \times 1 \times 10^{-6}}{\dfrac{H}{R \times T_{wk}}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-12	**Ldif**	g/yr	**2.43E-01**	--
CALC: B-4-19	**K_v**	m/yr	1.21E-03	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[1]	g/s	2.30E-04	--
COPC SPECIFIC	**F_v**[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Cywv_{wb}$**[3]	µg-s/g-m^3	1.43E-03	--
SITE SPECIFIC	**A_w**[4]	m^2	1.80E+07	--
COPC SPECIFIC	**H**[5]	atm-m^3/mol	7.10E-10	--
CONSTANT	**R**[6]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	**T_{wk}**[6]	K	2.98E+02	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Yearly average air concentration from vapor phase (Cywv) over waterbody from AERMOD modeling runs

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[6]Table B-4-12, p. B-217, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-13
UNIVERSAL SOIL LOSS EQUATION (USLE)
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$X_e = RF \cdot K \cdot LS \cdot C \cdot PF \cdot \frac{907.18}{4047}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-13	**X_e**	kg/m^2-yr	**2.29E+00**	**--**
SITE SPECIFIC	**RF**[1]	yr^{-1}	1.75E+02	**--**
SITE SPECIFIC	**K**[2]	ton/acre	3.90E-01	**--**
SITE SPECIFIC	**LS**[2]	unitless	1.50E+00	**--**
SITE SPECIFIC	**C**[2]	unitless	1.00E-01	**--**
SITE SPECIFIC	**PF**[2]	unitless	1.00E+00	**--**

[1]USLE Rainfall Erosivity Factor - median of HHRAP recommended defaut range between 50-300.
[2]Table B-4-13, pp. B-219 and B-220, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-14
SEDIMENT DELIVERY RATIO
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$SD = a \cdot (A_L)^{-b}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-14	**SD**	unitless	**3.79E-02**	**--**
SITE SPECIFIC	**a**[1]	unitless	6.00E-01	**--**
SITE SPECIFIC	**A_L**[2]	m^2	3.91E+09	**--**
SITE SPECIFIC	**b**[1]	unitless	1.25E-01	**--**

[1]Table B-4-14, pp. B-223 and B-224, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-15
TOTAL WATER BODY CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C'_{wtot} = \frac{L'_T}{\left(Vf'_x + V_{Dis}\right) \times f_{wc} + k_{wt} \times A_w \times \left(d_{wc} + d_{bs}\right)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-15	**C'_{wtot}**	g/m^3 (mg/L)	**1.09E-06**	--
CALC: B-4-7	**L'_T**	g/yr	2.85E+01	--
SITE SPECIFIC	**Vf'_x[1]**	m^3/yr	1.35E+09	--
SITE SPECIFIC	**V_{Dis}[2]**	m^3/yr	3.93E+06	
CALC: B-4-16	**f_{wc}**	unitless	3.49E-03	--
CALC: B-4-17	**k_{wt}**	yr^{-1}	5.89E-01	--
SITE SPECIFIC	**A_w[3]**	m^2	1.80E+07	--
SITE SPECIFIC	**d_{wc}[4]**	m	2.00E+00	--
SITE SPECIFIC	**d_{bs}[5]**	m	3.00E-02	--

[1]Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[2]V_{Dis}, proposed volumetric flow rate of the wastewater discharges and has been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper.

[3]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[4]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroelectric Project, FERC NO. 2206, Water Resources Work Group (April 30, 2004).

[5]Table B-4-15, p. B-228, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-16
FRACTION IN WATER COLUMN AND BENTHIC SEDIMENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$f_{wc} = \frac{(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}) \cdot d_{wc} / d_z}{(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}) \cdot d_{wc} / d_z + (\theta_{bs} + Kd_{bs} \cdot C_{BS}) \cdot d_{bs} / d_z}$$

$$f_{bs} = 1 - f_{wc}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-16	**f_{wc}**	unitless	**3.49E-03**	--
CALC: B-4-16	**f_{bs}**	unitless	**9.97E-01**	--
COPC SPECIFIC	**Kd_{sw}**[1]	L/kg SS	1.00E+05	--
SITE SPECIFIC	**TSS**[2]	mg/L	1.63E+01	--
SITE SPECIFIC	**d_{wc}**[3]	m	2.00E+00	--
SITE SPECIFIC	**d_z**[4]	m	2.03E+00	--
SITE SPECIFIC	**θ_{bs}**[5]	unitless	6.00E-01	--
COPC SPECIFIC	**Kd_{bs}**[1]	L / kg BS	5.00E+04	--
SITE SPECIFIC	**C_{BS}**[5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[3]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[4]d_z (Total water body depth) = d_{bs} + $d_{wc.}$

[5]Table B-4-16, pp. B-232 and B-233, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-17
OVERALL TOTAL WATER BODY DISSIPATION RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_{wt} = f_{wc} \cdot k_v + f_{bs} \cdot k_b$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-17	$\mathbf{k_{wt}}$	yr^{-1}	**5.89E-01**	--
CALC: B-4-16	$\mathbf{f_{wc}}$	unitless	3.49E-03	--
CALC: B-4-18	$\mathbf{k_{v}}$	yr^{-1}	2.26E-04	--
CALC: B-4-16	$\mathbf{f_{bs}}$	unitless	9.97E-01	--
CALC: B-4-22	$\mathbf{k_{b}}$	yr^{-1}	5.91E-01	--

TABLE B-4-18
WATER COLUMN VOLATILIZATION LOSS RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_v = \frac{K_v}{d_z \cdot (1 + Kd_{sw} \cdot TSS \cdot 10^{-6})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-18	**k_v**	yr^{-1}	**2.257E-04**	--
CALC: B-4-19	**K_v**	m/yr	1.21E-03	--
SITE SPECIFIC	**d_z[1]**	m	2.03E+00	--
COPC SPECIFIC	**Kd_{sw}[2]**	m	1.00E+05	--
SITE SPECIFIC	**TSS[3]**	m	1.63E+01	--

[1]d_z (Total water body depth) = d_{bs} + $d_{wc.}$
[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-19
OVERALL COPC TRANSFER RATE COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$K_v = \left[K_L^{-1} + \left(K_G \cdot \frac{H}{R \cdot T_{wk}} \right)^{-1} \right]^{-1} \cdot \theta^{(T_{wk} - 293)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-19	**K_v**	m/yr	**1.21E-03**	--
CALC: B-4-20	**$K_{L(river)}$**	m/yr	2.83E+02	--
CALC: B-4-21	**$K_{G(river)}$**	m/yr	3.65E+04	--
COPC SPECIFIC	**H**[1]	atm-m^3/mol	7.10E-10	--
CONSTANT	**R**[2]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	**T_{wk}**[2]	K	2.98E+02	--
SITE SPECIFIC	**θ**[2]	unitless	1.03E+00	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[2]Table B-4-19, p. B-243, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-20
LIQUID PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_L = \sqrt{\frac{(1 \times 10^{-4}) \cdot D_w \cdot u}{d_z}} \cdot 3.1536 \times 10^7$$

For Quiescent Lakes or Ponds

$$K_L = (C_d^{0.5} \cdot W) \cdot (\frac{\rho_a}{\rho_w})^{0.5} \cdot \frac{k^{0.33}}{\lambda_z} \cdot (\frac{\mu_w}{\rho_w \cdot D_w})^{-0.67} \cdot 3.1536 \times 10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-20	**K_L(river)**	m/yr	**2.83E+02**	--
CALC: B-4-20	**K_L(pond)**	m/yr	**1.17E+02**	--
COPC SPECIFIC	**D_w[1]**	cm^2/s	5.25E-06	--
SITE SPECIFIC	**u[2]**	m/s	3.11E-01	--
SITE SPECIFIC	**d_z[3]**	m	2.03E+00	--
SITE SPECIFIC	**C_d[4]**	unitless	1.10E-03	--
SITE SPECIFIC	**W[4]**	m/s	3.90E+00	--
SITE SPECIFIC	**ρ_a[4]**	g/cm^3	1.20E-03	--
SITE SPECIFIC	**ρ_w[4]**	g/cm^3	1.00E+00	--
CONSTANT	**k[4]**	unitless	4.00E-01	--
SITE SPECIFIC	**λ_z[4]**	unitless	4.00E+00	--
CONSTANT	**μ_w[4]**	g/cm-s	1.69E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Stream Velocity data (60 Day Average, Sep 15 - Nov 14) for USGS 02135200 Pee Dee River AT Hwy 701 NR Bucksport, SC
(URL: www.waterdata.usgs.gov).

[3]d_z (Total water body depth) = d_{bs} + $d_{wc.}$

[4]Table B-4-20, pp. B-246 and B-247, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-21
GAS PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_G = 36500 \ m/yr$$

For Quiescent Lakes or Ponds

$$K_G = (C_d^{0.5} \cdot W) \cdot \frac{k^{0.33}}{\lambda_z} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot 3.1536\times10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-21	**K_G(river)[1]**	**m/yr**	**3.65E+04**	**--**
CALC: B-4-21	**K_G(pond)**	**m/yr**	4.06E+05	**--**
SITE SPECIFIC	**C_d[1]**	**unitless**	1.10E-03	**--**
SITE SPECIFIC	**W[1]**	**m/s**	3.90E+00	**--**
CONSTANT	**k[1]**	**unitless**	4.00E-01	**--**
SITE SPECIFIC	**λ_z[1]**	**unitless**	4.00E+00	**--**
SITE SPECIFIC	**μ_a[1]**	**g/cm-s**	1.81E-04	**--**
SITE SPECIFIC	**ρ_a[1]**	**g/cm^3**	1.20E-03	**--**
COPC SPECIFIC	**D_a[2]**	**cm^2/s**	6.00E-02	**--**

[1]Table B-4-21, pp. B-249 and B-250, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005
[2]Table 7, Section 6.5, Page 28, Deposition Parameterizations for the Industrial Source Complex (ISC3) June 2002.

TABLE B-4-22
BENTHIC BURIAL RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_b = \left(\frac{X_e \cdot A_L \cdot SD \cdot 1 \times 10^3 - Vf_x \cdot TSS}{A_w \cdot TSS} \right) \cdot \left(\frac{TSS \cdot 1 \times 10^{-6}}{C_{BS} \cdot d_{bs}} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-22	$\mathbf{k_b}$	yr^{-1}	**5.908E-01**	--
CALC: B-4-13	$\mathbf{X_e}$	kg/m^2-yr	2.29E+00	--
SITE SPECIFIC	$\mathbf{A_L}$[1]	m^2	3.91E+09	--
CALC: B-4-14	**SD**	unitless	3.79E-02	--
SITE SPECIFIC	$\mathbf{Vf'_x}$[2]	m^3/yr	1.35E+09	--
SITE SPECIFIC	**TSS**[3]	mg/L	1.63E+01	--
SITE SPECIFIC	$\mathbf{A_w}$[4]	m^2	1.80E+07	--
SITE SPECIFIC	$\mathbf{C_{BS}}$[5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	$\mathbf{d_{bs}}$[5]	m	3.00E-02	--

[1]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[2]Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[4]A_w, Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5]Table B-4-22, p. B-255, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-23
TOTAL WATER COLUMN CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{wctot} = f_{wc} \cdot C_{wtot} \cdot \frac{d_{wc} + d_{bs}}{d_{wc}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-23	C_{wctot}	mg/L	**3.864E-09**	--
CALC: B-4-16	f_{wc}	unitless	3.49E-03	--
CALC: B-4-15	C_{wtot}	mg/L	1.09E-06	--
SITE SPECIFIC	d_{wc}[1]	m	2.00E+00	--
SITE SPECIFIC	d_{bs}[2]	m	3.00E-02	--

[1]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).
[2]Table B-4-23, p. B-258, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-24
DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{dw} = \frac{C_{wctot}}{1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-24	**$C_{dw(Pee\ Dee)}$**	mg/L	**1.25E-09**	**2.20E-10**
COPC SPECIFIC	**% MeHg[1]**	%	85.00%	15.00%
CALC: B-4-23	**C_{wctot}**	mg/L	3.86E-09	**--**
COPC SPECIFIC	**Kd_{sw}[2]**	L/kg SS	1.00E+05	**--**
SITE SPECIFIC	**TSS[3]**	mg/L	1.63E+01	**--**

[1]Divalent Mercury speciation split in the water body is assumed 85% Hg^{2+} and 15% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-27
FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF FISH EQUATIONS)

$$C_{fish} = C_{dw} \cdot BAF_{fish}$$

Concentration in fish based on the Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg fish tissue	**5.88E-04**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	mg/L	2.20E-10
COPC SPECIFIC	BAF_{fish}[1]	L/kg fish tissue	2.67E+06

[1]Table 1, Section 3.1.3.1.3, p. 21.,Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Median and Highest Background Concentration in Fish

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
SITE SPECIFIC	$C_{fish(median)}$[1]	mg/kg fish tissue	**8.90E-01**
SITE SPECIFIC	$C_{fish(highest)}$[1]	mg/kg fish tissue	**7.00E+00**

[1]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE B-5-1
AIR CONCENTRATION
(DIRECT INHALATION EQUATION)

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v + (1 - F_v) \cdot Cyp\right]$$

For Elemental Mercury, F_v = 1.0, therefore:

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: B-5-1	**C_a**	µg/m^3	**1.52E-07**
SOURCE AND COPC SPECIFIC	**$Q_{(Hg0)}$**[1]	g/s	1.33E-05
COPC SPECIFIC	**F_v**[2]	unitless	1.00E+00
COPC AND SOURCE SPECIFIC	**Cyv**[3]	µg-s/g-m^3	1.14E-02

[1]Q(Hg0) = Q (total mercury) * 0.8% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2 of mercury deposition and risk assessment report.

[3]Unitized yearly air concentration from vapor phase from AERMOD Runs.

TABLE C-1-4
COPC INTAKE FROM FISH

$$I_{fish} = C_{fish} \cdot CR_{fish} \cdot F_{fish}$$

Intake Based on Proposed Pee Dee Facility Emissions

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	**2.43E-07**
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg	5.88E-04
EXPOSURE PARAMETER	$CR_{fish(fisher\ child)}$[1]	kg/kg fish tissue-day	4.13E-04
SITE SPECIFIC	F_{fish}[2]	unitless	1.00E+00

[2]Based on the Mean Fish Consumption for the Age Group of 0-9 years (Table 10-2, Appendix 10A, Exposure Factors Handbook by USEPA, August 1997) for a child (6.2g/child) with an average body weight of a child as 15 kg (Table C-1-5, Appendix C, HHRAP by USEPA, September 2005).

[2]F_{fish} - Fraction of fish that is contaminated, Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Intake Based on Median Background Concentration in the Little Pee Dee River[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	**3.68E-04**
SITE SPECIFIC	$C_{fish(median)}$[2]	mg/kg	8.90E-01

[1]I_{fish}, based on Fisher Child consumption rate and $F_{fish} = 1.0$

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

Intake Based on Highest Background Concentration in the Little Pee Dee River[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	**2.89E-03**
SITE SPECIFIC	$C_{fish(highest)}$[2]	mg/kg	7.00E+00

[1]I_{fish}, based on Fisher Child consumption rate and $F_{fish} = 1.0$

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE C-1-5
COPC INTAKE FROM DRINKING WATER

$$I_{dw} = \frac{C_{dw} \cdot CR_{dw} \cdot F_{dw}}{BW}$$

TYPE	COPC CAS NO. PARAMETERS	Methyl Mercury 22967-92-6
CALC: C-1-5	$I_{dw(Pee\ Dee)}$	**9.84E-12**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	2.20E-10
EXPOSURE PARAMETER	CR_{dw}[1]	6.70E-01
SITE SPECIFIC	F_{dw}[1]	1.00E+00
EXPOSURE PARAMETER	BW[1]	1.50E+01

[1]Table C-1-5, p. C-18, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE C-1-6
TOTAL DAILY INTAKE

$$I = I_{soil} + I_{ag} + I_{beef} + I_{milk} + I_{fish} + I_{pork} + I_{poultry} + I_{eggs} + I_{dw}$$

Intake Based on Emissions from Proposed Pee Dee Facility[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(Pee\ Dee)}$	mg/kg-day	**2.43E-07**
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	2.43E-07
CALC: C-1-5	I_{dw}[1]	mg/kg-day	9.84E-12

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Median Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(median)}$	mg/kg-day	**3.68E-04**
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	3.68E-04

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Highest Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(highest)}$	mg/kg-day	**2.89E-03**
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	2.89E-03

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

TABLE C-1-8
HAZARD QUOTIENT (INDEX) : NONCARCINOGENS[1]

$$HQ = \frac{I \cdot ED \cdot EF}{RfD \cdot AT \cdot 365}$$

[1]The Hazard Index (HI) is equal to Hazard Quotient (HQ) since methlymercury is the only COPC for which an HQ is calculated.

Impact Based on Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$\mathbf{HQ}_{\text{fisher child(Pee Dee)}}$	unitless	**2.33E-03**
CALC: C-1-6	$\mathbf{I}_{\text{(Pee Dee)}}$	mg/kg-day	2.43E-07
EXPOSURE PARAMETER	**ED**[1]	yr	6
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Median Background Concentration in Little Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$\mathbf{HQ}_{\text{fisher child(median)}}$	unitless	**3.52**
CALC: C-1-6	$\mathbf{I}_{\text{(median)}}$	mg/kg-day	3.68E-04
EXPOSURE PARAMETER	**ED**[1]	yr	6
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Highest Background Concentration in Little Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$\mathbf{HQ}_{\text{fisher child(highest)}}$	unitless	**27.72**
CALC: C-1-6	$\mathbf{I}_{\text{(highest)}}$	mg/kg-day	2.89E-03
EXPOSURE PARAMETER	**ED**[1]	yr	6
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

CUMULATIVE HAZARD QUOTIENT (INDEX): NONCARCINOGENS

Average Child Scenario

TYPE	SOURCE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
INDIVIUAL	Proposed Pee Dee Facility Emissions	$HQ_{fisher\ child\ (Pee\ Dee)}$	unitless	2.33E-03
	Median Background Concentration	$HQ_{fisher\ child\ (median)}$	unitless	3.52
	Highest Background Concentration	$HQ_{fisher\ child\ (highest)}$	unitless	27.72
% CONTRIBUTION	Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	%	unitless	0.07%
	Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	%	unitless	0.01%

TABLE C-2-2
INHALATION HAZARD QUOTIENT

$$HQ_{inh(i)} = \frac{EC * 0.001}{RfC}$$

$$EC = \frac{C_a \cdot EF \cdot ED}{AT \cdot 365\ days/year}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: C-1-5	**$HQ_{(inh)}$**	unitless	**1.32E-07**
CALC: C-1-5	**EC**	$\mu g/m^3$	1.46E-07
EXPOSURE PARAMETER	**RfC**[1]	mg/m^3	1.10E-03
CALC: B-5-1	**C_a**	$\mu g/m^3$	1.52E-07
SITE SPECIFIC	**EF**[2]	days/yr	3.50E+02
EXPOSURE PARAMETER	**ED**[2]	yr	6.00E+00
EXPOSURE PARAMETER	**AT**[2]	yr	6.00E+00

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table C-2-2, pp. C-37 and C-38, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-1
WATERSHED SOIL CONCENTRATION DUE TO DEPOSITION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$Cs_{tD} = \frac{Ds \times \left(1 - \exp(-ks \cdot tD)\right)}{ks}$$

$$Ds = \frac{100 \cdot Q'_{(Hg2+)}}{Z_s \cdot BD} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	**2.74E-05**	**5.58E-07**
SITE- AND CONTAMINANT-SPECIFIC	**% MeHg**[1]	%	98%	2%
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
CALC: B-4-1	**D_s**	mg/kg soil-yr	**9.13E-07**	**1.86E-08**
COPC AND SOURCE SPECIFIC	**$Dytwv_{ws}$**[3]	s/m2-yr	1.23E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{ws}$**[3]	s/m2-yr	1.03E-04	--
COPC SPECIFIC	**F_v**[4]	unitless	9.90E-01	--
CALC: B-1-2	**ks**	yr^{-1}	2.052E-05	1.72E-04
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[5]	g/s	2.30E-04	--
SITE SPECIFIC	**tD**[2]	yr	3.00E+01	3.00E+01
SITE SPECIFIC	**Z_s**[2]	m	2.00E+01	2.00E+01

[1]Divalent Mercury speciation split in soils is assumed 98% Hg2+ and 2% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Table B-4-1, Appendix B, p. B-170 and p. B-172, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over watershed from AERMOD Model Runs.

[4]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[5]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes contriburtion from both Boilers (2*57.8 lbs = 115.6 lbs/yr).

TABLE B-4-2
COPC SOIL LOSS CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ks = ksg + kse + ksr + ksl + ksv$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-2	**ks**	yr^{-1}	**2.05E-05**	**1.72E-04**
COPC-SPECIFIC	**ksg**[1]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-3	**kse**[2]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-4	**ksr**	yr^{-1}	1.73E-05	1.43E-04
CALC: B-4-5	**ksl**	yr^{-1}	3.22E-06	2.67E-05
CALC: B-1-6	**ksv**	yr^{-1}	3.86E-10	1.86E-06

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]HHRAP recommended kse default value of zero for mercuric chloride, and methylmercury. Table B-4-2, Appendix B, p. B-177, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-3
COPC LOSS CONSTANT DUE TO SOIL EROSION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$kse = \frac{0.1 \cdot X_e \cdot SD \cdot ER}{BD \cdot Z_s} \cdot \left(\frac{Kd_s \cdot BD}{\theta_{sw} + (Kd_s \cdot BD)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-3	**kse**[1]	yr^{-1}	**0.00E+00**	**0.00E+00**
CALC: B-4-13	**X_e**	kg/m^2-yr	-	-
CALC: B-4-14	**SD**	unitless	-	-
COPC SPECIFIC	**ER**	unitless	-	-
SITE SPECIFIC	**BD**	g soil/cm^3 soil	-	-
SITE SPECIFIC	**Z_s**	cm	-	-
COPC SPECIFIC	**Kd_s**	cm^3 water/g soil	-	-
SITE SPECIFIC	**θsw**	mL/cm^3 soil	-	-

[1] Consistent with U.S. EPA (1994), U.S. EPA (1994b), and NC DEHNR (1997), the HHRAP recommends that the default value assumed for kse is zero because contaminated soil erodes both onto the site and away from the site. Uncertainty may overestimate kse. Table B-4-3, Appendix B, p. B-180, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-4
COPC LOSS CONSTANT DUE TO RUNOFF
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksr = \frac{RO}{\theta_{sw} \cdot Z_s} \cdot \left(\frac{1}{1 + \left(Kd_s \cdot BD / \theta_{sw} \right)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-4	**ksr**	yr^{-1}	**1.73E-05**	**1.43E-04**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	**Z_s**[3]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]Table B-4-4, pp. B-186 and B-187, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Assumed Tilled soil, value based on Table B-4-4, pp. B-186, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-5
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksl = \frac{P + I - OR - E_v}{\theta_{sw} \cdot Z_s \cdot \left[1.0 + \left(BD \cdot Kd_s / \theta_{sw}\right)\right]}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-5	**ksl**	yr^{-1}	**3.22E-06**	**2.67E-05**
SITE SPECIFIC	**P**[1]	cm/yr	1.14E+02	1.14E+02
SITE SPECIFIC	**I**[2]	cm/yr	2.00E+01	2.00E+01
SITE SPECIFIC	**RO**[3]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	E_v[4]	cm/yr	9.83E+01	9.83E+01
SITE SPECIFIC	θ_{sw}[5]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	Z_s[5]	cm	2.00E+01	2.00E+01
SITE SPECIFIC	**BD**[5]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	Kd_s[6]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Monthly Stations Normals of Temperature, Precipitation and Heating and Cooling Degree Days (1971-2000) for South Carolina by Nationa Oceanic and Atmospheric Administration (Feburary 2002), the Florence RGNL AP Site was chosen (closest to Pee Dee Facility).

[2]Value derived using 2003 National Resources Inventory (NRI) -Annual Irrigation Input for Model Simulations. Value represents geospatial average across Pee Dee Watershed. (ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/croplandreport)

[3]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[4]Amatya, D. M., Trettin, C. 2007. Annual evapotranspiration of a forested wetland watershed, SC at ASABE Annual International Meeting, June 17 - 20, 2007, p. 16. (URL: http://asae.frymulti.com/abstract.asp?aid=22992&t=2)

[5]Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[6]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-6
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksv = \left[\frac{3.1536 \times 10^{7} \cdot H}{Z_s \cdot Kd_s \cdot R \cdot T_a \cdot BD}\right] \cdot \left(\frac{D_a}{Z_s}\right) \cdot \left[1 - \left(\frac{BD}{\rho_{soil}}\right) - \theta_{sw}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-6	**ksv**	yr^{-1}	**3.86E-10**	**1.86E-06**
COPC SPECIFIC	**H**[1]	$atm\text{-}m^3/mol$	7.10E-10	4.70E-07
SITE SPECIFIC	**Z_s**[2]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[1]	cm^3 water/g soil	5.80E+04	7.00E+03
CONSTANT	**R**[2]	$atm\text{-}m^3/mol\text{-}K$	8.21E-05	8.21E-05
SITE SPECIFIC	**T_a**[2]	K	2.98E+02	2.98E+02
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	**D_a**[1]	cm^2/s	6.00E-02	5.28E-02
SITE SPECIFIC	**ρ_{soil}**[2]	g/cm^3	2.70E+00	2.70E+00
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table B-4-6, pp. B-195, B-196 and B-197, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-7
TOTAL WATER BODY LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_T = L_{DEP} + L_{dif} + L_{RI} + L_R + L_E + L_{Dis}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-7	L_T	g/yr	**2.85E+01**	--
CALC: B-4-8	L_{DEP}	g/yr	7.58E+00	--
CALC: B-4-12	L_{dif}	g/yr	2.43E-01	--
CALC: B-4-9	L_{RI}	g/yr	1.09E+01	--
CALC: B-4-10	L_R	g/yr	5.51E-01	--
CALC: B-4-11	L_E	g/yr	9.24E+00	--
Wastewater Discharges	L_{Dis}[1]	g/yr	3.93E-01	--

[1]$L_{Dis} = C_{Dis} \times V_{Dis}$. Where, C_{Dis} (concentration of mercury in wastewater discharges) and V_{Dis} (proposed volumetric flow rate of the wastewater discharges). C_{Dis} and V_{Dis} have been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper. Original HHRAP equation modified to include the additional loading term $L_{DIS.}$

TABLE B-4-8
DEPOSITION TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L'_{DEP} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{wb} + (1 - F_v) \cdot Dytwp_{wb}\right] \cdot A_w$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-8	**L'_{DEP}**	g/yr	**7.58E+00**	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[1]	g/s	2.30E-04	--
COPC SPECIFIC	**F_v**[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Dytwv_{wb}$**[3]	s/m^2-yr	1.85E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{wb}$**[3]	s/m^2-yr	1.42E-04	--
SITE SPECIFIC	**A_w**[4]	m^2	1.80E+07	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{wb}$) and particle bound ($Dytwp_{wb}$) deposition over waterbody from AERMOD Model Runs.

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-9
IMPERVIOUS RUNOFF LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{RI} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{ws} + (1 - F_v) \cdot Dytwp_{ws}\right] \cdot A_I$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-9	**L_{RI}**	g/yr	**1.09E+01**	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$[1]**	g/s	2.30E-04	--
COPC SPECIFIC	**F_v[2]**	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Dytwv_{ws}$[3]**	s/m^2-yr	1.23E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{ws}$[3]**	s/m^2-yr	1.03E-04	--
SITE SPECIFIC	**A_I[4]**	m^2	3.91E+07	--

[1]Total Mercury Emissions from 2 Boilers (2*57.8 lbs = 115.6 lbs/yr), which includes the loss to global cycle.
[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.
[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over waterbody from AERMOD Model Runs.
[4]A_I, impervious surface area of watershed, calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

TABLE B-4-10
PERVIOUS RUNOFF LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_R = RO \cdot (A_L - A_I) \cdot \frac{Cs \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.01$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-10	**L_R**	g/yr	**5.505E-01**	**9.29E-02**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**A_L**[2]	m^2	3.91E+09	3.91E+09
SITE SPECIFIC	**A_I**[3]	m^2	3.91E+07	3.91E+07
CALC: B-4-1	**CstD**	mg/kg soil	2.74E-05	5.58E-07
SITE SPECIFIC	**BD**[4]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[4]	mL/cm^3 soil	2.00E-01	2.00E-01
COPC SPECIFIC	**Kd_s**[5]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[3]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

[4]Table B-4-10, p. B-208, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-11
EROSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_E = X_e \cdot (A_L - A_I) \cdot SD \cdot ER \cdot \frac{Cs \cdot Kd_s \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.001$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-11	**L_E**	g/yr	**9.24E+00**	**1.88E-01**
CALC: B-4-13	**X_e**	kg soil /m^2-yr	2.29E+00	2.29E+00
SITE SPECIFIC	**A_L**[1]	m^2	3.91E+09	3.91E+09
SITE SPECIFIC	**A_I**[2]	m^2	3.91E+07	3.91E+07
CALC: B-4-14	**SD**	unitless	3.79E-02	3.79E-02
SITE SPECIFIC	**ER**[3]	unitless	1.00E+00	1.00E+00
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	2.74E-05	5.58E-07
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[3]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[3]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).
[2]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.
[3]Table B-4-11, p. B-212, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.
[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-12
DIFFUSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{dif} = \frac{K_v \times Q'_{(Hg\,2+)} \times F_v \times Cyvw_{wb} \times A_w \times 1 \times 10^{-6}}{\dfrac{H}{R \times T_{wk}}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-12	**Ldif**	g/yr	**2.43E-01**	--
CALC: B-4-19	**K_v**	m/yr	1.21E-03	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[1]	g/s	2.30E-04	--
COPC SPECIFIC	**F_v**[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Cywv_{wb}$**[3]	µg-s/g-m^3	1.43E-03	--
SITE SPECIFIC	**A_w**[4]	m^2	1.80E+07	--
COPC SPECIFIC	**H**[5]	atm-m^3/mol	7.10E-10	--
CONSTANT	**R**[6]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	**T_{wk}**[6]	K	2.98E+02	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Yearly average air concentration from vapor phase (Cywv) over waterbody from AERMOD modeling runs

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[6]Table B-4-12, p. B-217, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-13
UNIVERSAL SOIL LOSS EQUATION (USLE)
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$X_e = RF \cdot K \cdot LS \cdot C \cdot PF \cdot \frac{907.18}{4047}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-13	**X_e**	kg/m^2-yr	**2.29E+00**	--
SITE SPECIFIC	**RF**[1]	yr^{-1}	1.75E+02	--
SITE SPECIFIC	**K**[2]	ton/acre	3.90E-01	--
SITE SPECIFIC	**LS**[2]	unitless	1.50E+00	--
SITE SPECIFIC	**C**[2]	unitless	1.00E-01	--
SITE SPECIFIC	**PF**[2]	unitless	1.00E+00	--

[1]USLE Rainfall Erosivity Factor - median of HHRAP recommended defaut range between 50-300.

[2]Table B-4-13, pp. B-219 and B-220, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-14
SEDIMENT DELIVERY RATIO
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$SD = a \cdot (A_L)^{-b}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-14	**SD**	unitless	**3.79E-02**	**--**
SITE SPECIFIC	**a**[1]	unitless	6.00E-01	**--**
SITE SPECIFIC	**A_L**[2]	m^2	3.91E+09	**--**
SITE SPECIFIC	**b**[1]	unitless	1.25E-01	**--**

[1]Table B-4-14, pp. B-223 and B-224, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-15
TOTAL WATER BODY CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C'_{wtot} = \frac{L'_T}{\left(Vf'_x + V_{Dis}\right) \times f_{wc} + k_{wt} \times A_w \times \left(d_{wc} + d_{bs}\right)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-15	**C'_{wtot}**	g/m^3 (mg/L)	**1.09E-06**	--
CALC: B-4-7	**L'_T**	g/yr	2.85E+01	--
SITE SPECIFIC	**Vf'_x** [1]	m^3/yr	1.35E+09	--
SITE SPECIFIC	**V_{Dis}** [2]	m^3/yr	3.93E+06	
CALC: B-4-16	**f_{wc}**	unitless	3.49E-03	--
CALC: B-4-17	**k_{wt}**	yr^{-1}	5.89E-01	--
SITE SPECIFIC	**A_w** [3]	m^2	1.80E+07	--
SITE SPECIFIC	**d_{wc}** [4]	m	2.00E+00	--
SITE SPECIFIC	**d_{bs}** [5]	m	3.00E-02	--

[1]Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[2]V_{Dis}, proposed volumetric flow rate of the wastewater discharges and has been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper.

[3]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[4]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroelectric Project, FERC NO. 2206, Water Resources Work Group (April 30, 2004).

[5]Table B-4-15, p. B-228, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-16
FRACTION IN WATER COLUMN AND BENTHIC SEDIMENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$f_{wc} = \frac{(1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}) \cdot d_{wc} / d_z}{(1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}) \cdot d_{wc} / d_z + (\theta_{bs} + Kd_{bs} \cdot C_{BS}) \cdot d_{bs} / d_z}$$

$$f_{bs} = 1 - f_{wc}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-16	f_{wc}	unitless	**3.49E-03**	--
CALC: B-4-16	f_{bs}	unitless	**9.97E-01**	--
COPC SPECIFIC	Kd_{sw}[1]	L/kg SS	1.00E+05	--
SITE SPECIFIC	TSS[2]	mg/L	1.63E+01	--
SITE SPECIFIC	d_{wc}[3]	m	2.00E+00	--
SITE SPECIFIC	d_z[4]	m	2.03E+00	--
SITE SPECIFIC	θ_{bs}[5]	unitless	6.00E-01	--
COPC SPECIFIC	Kd_{bs}[1]	L / kg BS	5.00E+04	--
SITE SPECIFIC	C_{BS}[5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	d_{bs}[5]	m	3.00E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[3]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[4]d_z (Total water body depth) = $d_{bs} + d_{wc}$.

[5]Table B-4-16, pp. B-232 and B-233, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-17
OVERALL TOTAL WATER BODY DISSIPATION RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_{wt} = f_{wc} \cdot k_v + f_{bs} \cdot k_b$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-17	$\mathbf{k_{wt}}$	yr^{-1}	**5.89E-01**	--
CALC: B-4-16	$\mathbf{f_{wc}}$	unitless	3.49E-03	--
CALC: B-4-18	$\mathbf{k_{v}}$	yr^{-1}	2.26E-04	--
CALC: B-4-16	$\mathbf{f_{bs}}$	unitless	9.97E-01	--
CALC: B-4-22	$\mathbf{k_{b}}$	yr^{-1}	5.91E-01	--

TABLE B-4-18
WATER COLUMN VOLATILIZATION LOSS RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_v = \frac{K_v}{d_z \cdot (1 + Kd_{sw} \cdot TSS \cdot 10^{-6})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-18	**k_v**	yr^{-1}	**2.257E-04**	**--**
CALC: B-4-19	**K_v**	m/yr	1.21E-03	**--**
SITE SPECIFIC	**d_z**[1]	m	2.03E+00	**--**
COPC SPECIFIC	**Kd_{sw}**[2]	m	1.00E+05	**--**
SITE SPECIFIC	**TSS**[3]	m	1.63E+01	**--**

[1]d_z (Total water body depth) = d_{bs} + $d_{wc.}$
[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-19
OVERALL COPC TRANSFER RATE COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$K_v = \left[K_L^{-1} + \left(K_G \cdot \frac{H}{R \cdot T_{wk}} \right)^{-1} \right]^{-1} \cdot \theta^{(T_{wk} - 293)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-19	$K_{v\ (river)}$	m/yr	**1.21E-03**	--
CALC: B-4-20	$K_{L\ (river)}$	m/yr	2.83E+02	--
CALC: B-4-21	K_G	m/yr	3.65E+04	--
COPC SPECIFIC	H[1]	atm-m^3/mol	7.10E-10	--
CONSTANT	R[2]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	T_{wk}[2]	K	2.98E+02	--
SITE SPECIFIC	θ[2]	unitless	1.03E+00	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[2]Table B-4-19, p. B-243, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-20
LIQUID PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_L = \sqrt{\frac{(1 \times 10^{-4}) \cdot D_w \cdot u}{d_z}} \cdot 3.1536 \times 10^7$$

For Quiescent Lakes or Ponds

$$K_L = (C_d^{0.5} \cdot W) \cdot (\frac{\rho_a}{\rho_w})^{0.5} \cdot \frac{k^{0.33}}{\lambda_z} \cdot (\frac{\mu_w}{\rho_w \cdot D_w})^{-0.67} \cdot 3.1536 \times 10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-20	**K_L(river)**	m/yr	**2.83E+02**	--
CALC: B-4-20	**K_L(pond)**	m/yr	**1.17E+02**	--
COPC SPECIFIC	**D_w[1]**	cm^2/s	5.25E-06	--
SITE SPECIFIC	**u[2]**	m/s	3.11E-01	--
SITE SPECIFIC	**d_z[3]**	m	2.03E+00	--
SITE SPECIFIC	**C_d[4]**	unitless	1.10E-03	--
SITE SPECIFIC	**W[4]**	m/s	3.90E+00	--
SITE SPECIFIC	**ρ_a[4]**	g/cm^3	1.20E-03	--
SITE SPECIFIC	**ρ_w[4]**	g/cm^3	1.00E+00	--
CONSTANT	**k[4]**	unitless	4.00E-01	--
SITE SPECIFIC	**λ_z[4]**	unitless	4.00E+00	--
CONSTANT	**μ_w[4]**	g/cm-s	1.69E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Stream Velocity data (60 Day Average, Sep 15 - Nov 14) for USGS 02135200 Pee Dee River AT Hwy 701 NR Bucksport, SC
(URL: www.waterdata.usgs.gov).

[3]d_z (Total water body depth) = d_{bs} + $d_{wc.}$

[4]Table B-4-20, pp. B-246 and B-247, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-21
GAS PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_G = 36500 \ m/yr$$

For Quiescent Lakes or Ponds

$$K_G = (C_d^{0.5} \cdot W) \cdot \frac{k^{0.33}}{\lambda_z} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot 3.1536\times10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-21	K_G(river)[1]	m/yr	**3.65E+04**	--
CALC: B-4-21	K_G(pond)	m/yr	4.06E+05	--
SITE SPECIFIC	C_d[1]	unitless	1.10E-03	--
SITE SPECIFIC	W[1]	m/s	3.90E+00	--
CONSTANT	k[1]	unitless	4.00E-01	--
SITE SPECIFIC	λ_z[1]	unitless	4.00E+00	--
SITE SPECIFIC	μ_a[1]	g/cm-s	1.81E-04	--
SITE SPECIFIC	ρ_a[1]	g/cm^3	1.20E-03	--
COPC SPECIFIC	D_a[2]	cm^2/s	6.00E-02	--

[1]Table B-4-21, pp. B-249 and B-250, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005
[2]Table 7, Section 6.5, Page 28, Deposition Parameterizations for the Industrial Source Complex (ISC3) June 2002.

TABLE B-4-22
BENTHIC BURIAL RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_b = \left(\frac{X_e \cdot A_L \cdot SD \cdot 1 \times 10^3 - Vf_x \cdot TSS}{A_w \cdot TSS} \right) \cdot \left(\frac{TSS \cdot 1 \times 10^{-6}}{C_{BS} \cdot d_{bs}} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-22	**k_b**	yr^{-1}	**5.908E-01**	--
CALC: B-4-13	**X_e**	kg/m^2-yr	2.29E+00	--
SITE SPECIFIC	**A_L** [1]	m^2	3.91E+09	--
CALC: B-4-14	**SD**	unitless	3.79E-02	--
SITE SPECIFIC	**Vf'_x** [2]	m^3/yr	1.35E+09	--
SITE SPECIFIC	**TSS** [3]	mg/L	1.63E+01	--
SITE SPECIFIC	**A_w** [4]	m^2	1.80E+07	--
SITE SPECIFIC	**C_{BS}** [5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	**d_{bs}** [5]	m	3.00E-02	--

[1] A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[2] Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[3] Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[4] A_w, Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5] Table B-4-22, p. B-255, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-23
TOTAL WATER COLUMN CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{wctot} = f_{wc} \cdot C_{wtot} \cdot \frac{d_{wc} + d_{bs}}{d_{wc}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-23	C_{wctot}	mg/L	**3.864E-09**	--
CALC: B-4-16	f_{wc}	unitless	3.49E-03	--
CALC: B-4-15	C_{wtot}	mg/L	1.09E-06	--
SITE SPECIFIC	d_{wc} [1]	m	2.00E+00	--
SITE SPECIFIC	d_{bs} [2]	m	3.00E-02	--

[1]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[2]Table B-4-23, p. B-258, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-24
DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{dw} = \frac{C_{wctot}}{1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-24	**$C_{dw(Pee\ Dee)}$**	mg/L	**1.25E-09**	**2.20E-10**
COPC SPECIFIC	**% MeHg**[1]	%	85.00%	15.00%
CALC: B-4-23	**C_{wctot}**	mg/L	3.86E-09	--
COPC SPECIFIC	**Kd_{sw}**[2]	L/kg SS	1.00E+05	--
SITE SPECIFIC	**TSS**[3]	mg/L	1.63E+01	--

[1]Divalent Mercury speciation split in the water body is assumed 85% Hg^{2+} and 15% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-27
FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF FISH EQUATIONS)

$$C_{fish} = C_{dw} \cdot BAF_{fish}$$

Concentration in fish based on the Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: B-4-27	$\mathbf{C_{fish(Pee\ Dee)}}$	mg/kg fish tissue	**5.88E-04**
CALC: B-4-24	$\mathbf{C_{dw(Pee\ Dee)}}$	mg/L	2.20E-10
COPC SPECIFIC	$\mathbf{BAF_{fish}}$[1]	L/kg fish tissue	2.67E+06

[1]Table 1, Section 3.1.3.1.3, p. 21.,Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Median and Highest Background Concentration in Fish

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
SITE SPECIFIC	$\mathbf{C_{fish(median)}}$[1]	mg/kg fish tissue	**8.90E-01**
SITE SPECIFIC	$\mathbf{C_{fish(highest)}}$[1]	mg/kg fish tissue	**7.00E+00**

[1]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE B-5-1
AIR CONCENTRATION
(DIRECT INHALATION EQUATION)

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v + (1 - F_v) \cdot Cyp \right]$$

For Elemental Mercury, F_v = 1.0, therefore:

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v \right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: B-5-1	**C_a**	µg/m^3	**1.52E-07**
SOURCE AND COPC SPECIFIC	**$Q_{(Hg0)}$**[1]	g/s	1.33E-05
COPC SPECIFIC	**F_v**[2]	unitless	1.00E+00
COPC AND SOURCE SPECIFIC	**Cyv**[3]	µg-s/g-m^3	1.14E-02

[1]Q(Hg0) = Q (total mercury) * 0.8% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2 of mercury deposition and risk assessment report.

[3]Unitized yearly air concentration from vapor phase from AERMOD Runs.

TABLE C-1-4
COPC INTAKE FROM FISH

$$I_{fish} = C_{fish} \cdot CR_{fish} \cdot F_{fish}$$

Intake Based on Proposed Pee Dee Facility Emissions

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	**7.36E-07**
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg	5.88E-04
EXPOSURE PARAMETER	$CR_{fish(subsistence\ fisher\ adult)}$ [1]	kg/kg fish tissue-day	1.25E-03
SITE SPECIFIC	F_{fish} [1]	unitless	1.00E+00

[1]Table C-1-4, p. C-15, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Intake Based on Median Background Concentration in Pee Dee River [1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	**1.11E-03**
SITE SPECIFIC	$C_{fish(median)}$ [2]	mg/kg	8.90E-01

[1]I_{fish}, based on Subsitence Fisher Adult consumption rate and F_{fish} = 1.0

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

Intake Based on Highest Background Concentration in Pee Dee River [1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	**8.75E-03**
SITE SPECIFIC	$C_{fish(highest)}$ [2]	mg/kg	7.00E+00

[1]I_{fish}, based on Subsitence Fisher Adult consumption rate and F_{fish} = 1.0

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE C-1-5
COPC INTAKE FROM DRINKING WATER

$$I_{dw} = \frac{C_{dw} \cdot CR_{dw} \cdot F_{dw}}{BW}$$

TYPE	COPC CAS NO. PARAMETERS	Methyl Mercury 22967-92-6
CALC: C-1-5	$I_{dw(Pee\ Dee)}$	**4.41E-12**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	2.20E-10
EXPOSURE PARAMETER	CR_{dw}[1]	1.40E+00
SITE SPECIFIC	F_{dw}[1]	1.00E+00
EXPOSURE PARAMETER	BW[1]	7.00E+01

[1]Table C-1-5, p. C-18, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE C-1-6
TOTAL DAILY INTAKE

$$I = I_{soil} + I_{ag} + I_{beef} + I_{milk} + I_{fish} + I_{pork} + I_{poultry} + I_{eggs} + I_{dw}$$

Intake Based on Emissions from Proposed Pee Dee Facility[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(Pee\ Dee)}$	mg/kg-day	**7.36E-07**
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	7.36E-07
CALC: C-1-5	I_{dw}[1]	mg/kg-day	4.41E-12

[1]I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Median Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(median)}$	mg/kg-day	**1.11E-03**
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	1.11E-03

[1]I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Highest Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(highest)}$	mg/kg-day	**8.75E-03**
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	8.75E-03

[1]I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

TABLE C-1-8
HAZARD QUOTIENT (INDEX) : NONCARCINOGENS[1]

$$HQ = \frac{I \cdot ED \cdot EF}{RfD \cdot AT \cdot 365}$$

[1]The Hazard Index (HI) is equal to Hazard Quotient (HQ) since methlymercury is the only COPC for which an HQ is calculated.

Impact Based on Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$HQ_{subsistence\ fisher\ adult\ (Pee\ Dee)}$	unitless	**7.05E-03**
CALC: C-1-6	$I_{(Pee\ Dee)}$	mg/kg-day	7.36E-07
EXPOSURE PARAMETER	**ED**[1]	yr	30
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Median Background Concentration in Great Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$HQ_{subsistence\ fisher\ adult\ (median)}$	unitless	**10.67**
CALC: C-1-6	$I_{(median)}$	mg/kg-day	1.11E-03
EXPOSURE PARAMETER	**ED**[1]	yr	30
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Highest Background Concentration in Great Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$HQ_{subsistence\ fisher\ adult\ (highest)}$	unitless	**83.90**
CALC: C-1-6	$I_{(highest)}$	mg/kg-day	8.75E-03
EXPOSURE PARAMETER	**ED**[1]	yr	30
EXPOSURE PARAMETER	**EF**[1]	days/yr	350
COPC SPECIFIC	**RfD**[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT**[1]	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

CUMULATIVE HAZARD QUOTIENT (INDEX): NONCARCINOGENS

Subsistence Fisher Adult Scenario

TYPE	SOURCE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
INDIVIUAL	Proposed Pee Dee Facility Emissions	$HQ_{\text{subsistence fisher adult (Pee Dee)}}$	unitless	7.05E-03
	Median Background Concentration	$HQ_{\text{subsistence fisher adult (median)}}$	unitless	10.67
	Highest Background Concentration	$HQ_{\text{subsistence fisher adult (highest)}}$	unitless	83.90
% CONTRIBUTION	Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	%	unitless	0.07%
	Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	%	unitless	0.01%

TABLE C-2-2
INHALATION HAZARD QUOTIENT

$$HQ_{inh(i)} = \frac{EC * 0.001}{RfC}$$

$$EC = \frac{C_a \cdot EF \cdot ED}{AT \cdot 365\ days/year}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: C-1-5	**$HQ_{(inh)}$**	unitless	**1.32E-07**
CALC: C-1-5	**EC**	$\mu g/m^3$	1.46E-07
EXPOSURE PARAMETER	**RfC**[1]	mg/m^3	1.10E-03
CALC: B-5-1	**C_a**	$\mu g/m^3$	1.52E-07
SITE SPECIFIC	**EF**[2]	days/yr	3.50E+02
EXPOSURE PARAMETER	**ED**[2]	yr	3.00E+01
EXPOSURE PARAMETER	**AT**[2]	yr	3.00E+01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table C-2-2, pp. C-37 and C-38, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-1
WATERSHED SOIL CONCENTRATION DUE TO DEPOSITION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$Cs_{tD} = \frac{Ds \times \left(1 - \exp(-ks \cdot tD)\right)}{ks}$$

$$Ds = \frac{100 \cdot Q'_{(Hg2+)}}{Z_s \cdot BD} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	**2.74E-05**	**5.58E-07**
SITE- AND CONTAMINANT-SPECIFIC	**% MeHg[1]**	%	98%	2%
SITE SPECIFIC	**BD[2]**	g soil/cm^3 soil	1.50E+00	1.50E+00
CALC: B-4-1	**D_s**	mg/kg soil-yr	**9.13E-07**	**1.86E-08**
COPC AND SOURCE SPECIFIC	**$Dytwv_{ws}$[3]**	s/m2-yr	1.23E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{ws}$[3]**	s/m2-yr	1.03E-04	--
COPC SPECIFIC	**F_v[4]**	unitless	9.90E-01	--
CALC: B-1-2	**ks**	yr^{-1}	2.052E-05	1.72E-04
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$[5]**	g/s	2.30E-04	--
SITE SPECIFIC	**tD[2]**	yr	3.00E+01	3.00E+01
SITE SPECIFIC	**Z_s[2]**	m	2.00E+01	2.00E+01

[1]Divalent Mercury speciation split in soils is assumed 98% Hg2+ and 2% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Table B-4-1, Appendix B, p. B-170 and p. B-172, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over watershed from AERMOD Model Runs.

[4]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[5]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes contriburtion from both Boilers (2*57.8 lbs = 115.6 lbs/yr).

TABLE B-4-2
COPC SOIL LOSS CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ks = ksg + kse + ksr + ksl + ksv$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-2	**ks**	yr^{-1}	**2.05E-05**	**1.72E-04**
COPC-SPECIFIC	**ksg**[1]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-3	**kse**[2]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-4	**ksr**	yr^{-1}	1.73E-05	1.43E-04
CALC: B-4-5	**ksl**	yr^{-1}	3.22E-06	2.67E-05
CALC: B-1-6	**ksv**	yr^{-1}	3.86E-10	1.86E-06

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]HHRAP recommended kse default value of zero for mercuric chloride, and methylmercury. Table B-4-2, Appendix B, p. B-177, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-3
COPC LOSS CONSTANT DUE TO SOIL EROSION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$kse = \frac{0.1 \cdot X_e \cdot SD \cdot ER}{BD \cdot Z_s} \cdot \left(\frac{Kd_s \cdot BD}{\theta_{sw} + (Kd_s \cdot BD)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-3	**kse**[1]	yr^{-1}	**0.00E+00**	**0.00E+00**
CALC: B-4-13	$\mathbf{X_e}$	kg/m^2-yr	-	-
CALC: B-4-14	**SD**	unitless	-	-
COPC SPECIFIC	**ER**	unitless	-	-
SITE SPECIFIC	**BD**	g soil/cm^3 soil	-	-
SITE SPECIFIC	$\mathbf{Z_s}$	cm	-	-
COPC SPECIFIC	$\mathbf{Kd_s}$	cm^3 water/g soil	-	-
SITE SPECIFIC	**θsw**	mL/cm^3 soil	-	-

[1] Consistent with U.S. EPA (1994), U.S. EPA (1994b), and NC DEHNR (1997), the HHRAP recommends that the default value assumed for kse is zero because contaminated soil erodes both onto the site and away from the site. Uncertainty may overestimate kse. Table B-4-3, Appendix B, p. B-180, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-4
COPC LOSS CONSTANT DUE TO RUNOFF
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksr = \frac{RO}{\theta_{sw} \cdot Z_s} \cdot \left(\frac{1}{1 + \left(Kd_s \cdot BD / \theta_{sw} \right)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-4	**ksr**	yr^{-1}	**1.73E-05**	**1.43E-04**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	**Z_s**[3]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00

[1] Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2] Table B-4-4, pp. B-186 and B-187, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3] Assumed Tilled soil, value based on Table B-4-4, pp. B-186, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[4] Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-5
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksl = \frac{P + I - OR - E_v}{\theta_{sw} \cdot Z_s \cdot \left[1.0 + \left(BD \cdot Kd_s / \theta_{sw}\right)\right]}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-5	**ksl**	yr^{-1}	**3.22E-06**	**2.67E-05**
SITE SPECIFIC	**P**[1]	cm/yr	1.14E+02	1.14E+02
SITE SPECIFIC	**I**[2]	cm/yr	2.00E+01	2.00E+01
SITE SPECIFIC	**RO**[3]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	E_v[4]	cm/yr	9.83E+01	9.83E+01
SITE SPECIFIC	θ_{sw}[5]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	Z_s[5]	cm	2.00E+01	2.00E+01
SITE SPECIFIC	**BD**[5]	g $soil/cm^3$ soil	1.50E+00	1.50E+00
COPC SPECIFIC	Kd_s[6]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Monthly Stations Normals of Temperature, Precipitation and Heating and Cooling Degree Days (1971-2000) for South Carolina by Nationa Oceanic and Atmospheric Administration (Feburary 2002), the Florence RGNL AP Site was chosen (closest to Pee Dee Facility).

[2]Value derived using 2003 National Resources Inventory (NRI) -Annual Irrigation Input for Model Simulations. Value represents geospatial average across Pee Dee Watershed. (ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/croplandreport)

[3]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[4]Amatya, D. M., Trettin, C. 2007. Annual evapotranspiration of a forested wetland watershed, SC at ASABE Annual International Meeting, June 17 - 20, 2007, p. 16. (URL: http://asae.frymulti.com/abstract.asp?aid=22992&t=2)

[5]Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[6]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-6
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksv = \left[\frac{3.1536 \times 10^{7} \cdot H}{Z_s \cdot Kd_s \cdot R \cdot T_a \cdot BD}\right] \cdot \left(\frac{D_a}{Z_s}\right) \cdot \left[1 - \left(\frac{BD}{\rho_{soil}}\right) - \theta_{sw}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-6	**ksv**	yr^{-1}	**3.86E-10**	**1.86E-06**
COPC SPECIFIC	**H**[1]	atm-m^3/mol	7.10E-10	4.70E-07
SITE SPECIFIC	$\mathbf{Z_s}$[2]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	$\mathbf{Kd_s}$[1]	cm^3 water/g soil	5.80E+04	7.00E+03
CONSTANT	**R**[2]	atm-m^3/mol-K	8.21E-05	8.21E-05
SITE SPECIFIC	$\mathbf{T_a}$[2]	K	2.98E+02	2.98E+02
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	$\mathbf{D_a}$[1]	cm^2/s	6.00E-02	5.28E-02
SITE SPECIFIC	$\boldsymbol{\rho_{soil}}$[2]	g/cm^3	2.70E+00	2.70E+00
SITE SPECIFIC	$\boldsymbol{\theta_{sw}}$[2]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table B-4-6, pp. B-195, B-196 and B-197, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-7
TOTAL WATER BODY LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_T = L_{DEP} + L_{dif} + L_{RI} + L_R + L_E + L_{Dis}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-7	L_T	g/yr	**2.85E+01**	--
CALC: B-4-8	L_{DEP}	g/yr	7.58E+00	--
CALC: B-4-12	L_{dif}	g/yr	2.43E-01	--
CALC: B-4-9	L_{RI}	g/yr	1.09E+01	--
CALC: B-4-10	L_R	g/yr	5.51E-01	--
CALC: B-4-11	L_E	g/yr	9.24E+00	--
Wastewater Discharges	L_{Dis}[1]	g/yr	3.93E-01	--

[1]$L_{Dis} = C_{Dis} \times V_{Dis}$. Where, C_{Dis} (concentration of mercury in wastewater discharges) and V_{Dis} (proposed volumetric flow rate of the wastewater discharges). C_{Dis} and V_{Dis} have been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper. Original HHRAP equation modified to include the additional loading term $L_{DIS.}$

TABLE B-4-8
DEPOSITION TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L'_{DEP} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{wb} + \left(1 - F_v\right) \cdot Dytwp_{wb}\right] \cdot A_w$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-8	$\mathbf{L'_{DEP}}$	g/yr	**7.58E+00**	--
COPC AND SOURCE SPECIFIC	$\mathbf{Q'_{(Hg2+)}}$[1]	g/s	2.30E-04	--
COPC SPECIFIC	$\mathbf{F_v}$[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwv_{wb}}$[3]	s/m^2-yr	1.85E-03	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwp_{wb}}$[3]	s/m^2-yr	1.42E-04	--
SITE SPECIFIC	$\mathbf{A_w}$[4]	m^2	1.80E+07	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{wb}$) and particle bound ($Dytwp_{wb}$) deposition over waterbody from AERMOD Model Runs.

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-9
IMPERVIOUS RUNOFF LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{RI} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right] \cdot A_I$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-9	$\mathbf{L_{RI}}$	g/yr	**1.09E+01**	--
COPC AND SOURCE SPECIFIC	$\mathbf{Q'_{(Hg2+)}}$ [1]	g/s	2.30E-04	--
COPC SPECIFIC	$\mathbf{F_v}$ [2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwv_{ws}}$ [3]	s/m^2-yr	1.23E-03	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwp_{ws}}$ [3]	s/m^2-yr	1.03E-04	--
SITE SPECIFIC	$\mathbf{A_I}$ [4]	m^2	3.91E+07	--

[1] Total Mercury Emissions from 2 Boilers (2*57.8 lbs = 115.6 lbs/yr), which includes the loss to global cycle.
[2] Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.
[3] Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over waterbody from AERMOD Model Runs.
[4] A_I, impervious surface area of watershed, calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

TABLE B-4-10
PERVIOUS RUNOFF LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_R = RO \cdot (A_L - A_I) \cdot \frac{Cs \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.01$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-10	**L_R**	g/yr	**5.505E-01**	**9.29E-02**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**A_L**[2]	m^2	3.91E+09	3.91E+09
SITE SPECIFIC	**A_I**[3]	m^2	3.91E+07	3.91E+07
CALC: B-4-1	**CstD**	mg/kg soil	2.74E-05	5.58E-07
SITE SPECIFIC	**BD**[4]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[4]	mL/cm^3 soil	2.00E-01	2.00E-01
COPC SPECIFIC	**Kd_s**[5]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[3]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

[4]Table B-4-10, p. B-208, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-11
EROSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_E = X_e \cdot (A_L - A_I) \cdot SD \cdot ER \cdot \frac{Cs \cdot Kd_s \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.001$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-11	**L_E**	g/yr	**9.24E+00**	**1.88E-01**
CALC: B-4-13	**X_e**	kg soil /m^2-yr	2.29E+00	2.29E+00
SITE SPECIFIC	**A_L**[1]	m^2	3.91E+09	3.91E+09
SITE SPECIFIC	**A_I**[2]	m^2	3.91E+07	3.91E+07
CALC: B-4-14	**SD**	unitless	3.79E-02	3.79E-02
SITE SPECIFIC	**ER**[3]	unitless	1.00E+00	1.00E+00
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	2.74E-05	5.58E-07
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[3]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[3]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).
[2]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.
[3]Table B-4-11, p. B-212, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-12
DIFFUSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{dif} = \frac{K_v \times Q'_{(Hg\,2+)} \times F_v \times Cyvw_{wb} \times A_w \times 1 \times 10^{-6}}{\dfrac{H}{R \times T_{wk}}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-12	**Ldif**	g/yr	**2.43E-01**	--
CALC: B-4-19	**K_v**	m/yr	1.21E-03	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[1]	g/s	2.30E-04	--
COPC SPECIFIC	**F_v**[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Cywv_{wb}$**[3]	µg-s/g-m^3	1.43E-03	--
SITE SPECIFIC	**A_w**[4]	m^2	1.80E+07	--
COPC SPECIFIC	**H**[5]	atm-m^3/mol	7.10E-10	--
CONSTANT	**R**[6]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	**T_{wk}**[6]	K	2.98E+02	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Yearly average air concentration from vapor phase (Cywv) over waterbody from AERMOD modeling runs

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[6]Table B-4-12, p. B-217, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-13
UNIVERSAL SOIL LOSS EQUATION (USLE)
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$X_e = RF \cdot K \cdot LS \cdot C \cdot PF \cdot \frac{907.18}{4047}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-13	**X_e**	kg/m^2-yr	**2.29E+00**	**--**
SITE SPECIFIC	**RF**[1]	yr^{-1}	1.75E+02	**--**
SITE SPECIFIC	**K**[2]	ton/acre	3.90E-01	**--**
SITE SPECIFIC	**LS**[2]	unitless	1.50E+00	**--**
SITE SPECIFIC	**C**[2]	unitless	1.00E-01	**--**
SITE SPECIFIC	**PF**[2]	unitless	1.00E+00	**--**

[1]USLE Rainfall Erosivity Factor - median of HHRAP recommended defaut range between 50-300.

[2]Table B-4-13, pp. B-219 and B-220, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-14
SEDIMENT DELIVERY RATIO
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$SD = a \cdot (A_L)^{-b}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-14	**SD**	unitless	**3.79E-02**	--
SITE SPECIFIC	**a**[1]	unitless	6.00E-01	--
SITE SPECIFIC	**A_L**[2]	m^2	3.91E+09	--
SITE SPECIFIC	**b**[1]	unitless	1.25E-01	--

[1]Table B-4-14, pp. B-223 and B-224, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-15
TOTAL WATER BODY CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C'_{wtot} = \frac{L'_T}{(Vf'_x + V_{Dis}) \times f_{wc} + k_{wt} \times A_w \times (d_{wc} + d_{bs})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-15	**C'_{wtot}**	g/m^3 (mg/L)	**1.09E-06**	--
CALC: B-4-7	**L'_T**	g/yr	2.85E+01	--
SITE SPECIFIC	**Vf'_x**[1]	m^3/yr	1.35E+09	--
SITE SPECIFIC	**V_{Dis}**[2]	m^3/yr	3.93E+06	
CALC: B-4-16	**f_{wc}**	unitless	3.49E-03	--
CALC: B-4-17	**k_{wt}**	yr^{-1}	5.89E-01	--
SITE SPECIFIC	**A_w**[3]	m^2	1.80E+07	--
SITE SPECIFIC	**d_{wc}**[4]	m	2.00E+00	--
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	--

[1]Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[2]V_{Dis}, proposed volumetric flow rate of the wastewater discharges and has been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper.

[3]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[4]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroelectric Project, FERC NO. 2206, Water Resources Work Group (April 30, 2004).

[5]Table B-4-15, p. B-228, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-16
FRACTION IN WATER COLUMN AND BENTHIC SEDIMENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$f_{wc} = \frac{(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}) \cdot d_{wc} / d_z}{(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}) \cdot d_{wc} / d_z + (\theta_{bs} + Kd_{bs} \cdot C_{BS}) \cdot d_{bs} / d_z}$$

$$f_{bs} = 1 - f_{wc}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-16	**f_{wc}**	unitless	**3.49E-03**	--
CALC: B-4-16	**f_{bs}**	unitless	**9.97E-01**	--
COPC SPECIFIC	**Kd_{sw}**[1]	L/kg SS	1.00E+05	--
SITE SPECIFIC	**TSS**[2]	mg/L	1.63E+01	--
SITE SPECIFIC	**d_{wc}**[3]	m	2.00E+00	--
SITE SPECIFIC	**d_z**[4]	m	2.03E+00	--
SITE SPECIFIC	**θ_{bs}**[5]	unitless	6.00E-01	--
COPC SPECIFIC	**Kd_{bs}**[1]	L / kg BS	5.00E+04	--
SITE SPECIFIC	**C_{BS}**[5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[3]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[4]d_z (Total water body depth) = d_{bs} + $d_{wc.}$

[5]Table B-4-16, pp. B-232 and B-233, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-17
OVERALL TOTAL WATER BODY DISSIPATION RATE CONSTANT (CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_{wt} = f_{wc} \cdot k_v + f_{bs} \cdot k_b$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-17	k_{wt}	yr^{-1}	**5.89E-01**	--
CALC: B-4-16	f_{wc}	unitless	3.49E-03	--
CALC: B-4-18	k_v	yr^{-1}	2.26E-04	--
CALC: B-4-16	f_{bs}	unitless	9.97E-01	--
CALC: B-4-22	k_b	yr^{-1}	5.91E-01	--

TABLE B-4-18
WATER COLUMN VOLATILIZATION LOSS RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_v = \frac{K_v}{d_z \cdot (1 + Kd_{sw} \cdot TSS \cdot 10^{-6})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-18	**k_v**	yr^{-1}	**2.257E-04**	--
CALC: B-4-19	**K_v**	m/yr	1.21E-03	--
SITE SPECIFIC	**d_z**[1]	m	2.03E+00	--
COPC SPECIFIC	**Kd_{sw}**[2]	m	1.00E+05	--
SITE SPECIFIC	**TSS**[3]	m	1.63E+01	--

[1]d_z (Total water body depth) = d_{bs} + $d_{wc.}$
[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-19
OVERALL COPC TRANSFER RATE COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$K_v = \left[K_L^{-1} + \left(K_G \cdot \frac{H}{R \cdot T_{wk}} \right)^{-1} \right]^{-1} \cdot \theta^{(T_{wk} - 293)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-19	$K_{v(river)}$	m/yr	**1.21E-03**	--
CALC: B-4-20	$K_{L(river)}$	m/yr	2.83E+02	--
CALC: B-4-21	K_G	m/yr	3.65E+04	--
COPC SPECIFIC	H[1]	atm-m^3/mol	7.10E-10	--
CONSTANT	R[2]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	T_{wk}[2]	K	2.98E+02	--
SITE SPECIFIC	θ[2]	unitless	1.03E+00	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[2]Table B-4-19, p. B-243, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-20
LIQUID PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_L = \sqrt{\frac{(1 \times 10^{-4}) \cdot D_w \cdot u}{d_z}} \cdot 3.1536 \times 10^7$$

For Quiescent Lakes or Ponds

$$K_L = (C_d^{0.5} \cdot W) \cdot (\frac{\rho_a}{\rho_w})^{0.5} \cdot \frac{k^{0.33}}{\lambda_z} \cdot (\frac{\mu_w}{\rho_w \cdot D_w})^{-0.67} \cdot 3.1536 \times 10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-20	**K_L(river)**	m/yr	**2.83E+02**	--
CALC: B-4-20	**K_L(pond)**	m/yr	**1.17E+02**	--
COPC SPECIFIC	**D_w[1]**	cm^2/s	5.25E-06	--
SITE SPECIFIC	**u[2]**	m/s	3.11E-01	--
SITE SPECIFIC	**d_z[3]**	m	2.03E+00	--
SITE SPECIFIC	**C_d[4]**	unitless	1.10E-03	--
SITE SPECIFIC	**W[4]**	m/s	3.90E+00	--
SITE SPECIFIC	**ρ_a[4]**	g/cm^3	1.20E-03	--
SITE SPECIFIC	**ρ_w[4]**	g/cm^3	1.00E+00	--
CONSTANT	**k[4]**	unitless	4.00E-01	--
SITE SPECIFIC	**λ_z[4]**	unitless	4.00E+00	--
CONSTANT	**μ_w[4]**	g/cm-s	1.69E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Stream Velocity data (60 Day Average, Sep 15 - Nov 14) for USGS 02135200 Pee Dee River AT Hwy 701 NR Bucksport, SC
(URL: www.waterdata.usgs.gov).

[3]d_z (Total water body depth) = d_{bs} + $d_{wc.}$

[4]Table B-4-20, pp. B-246 and B-247, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-21
GAS PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_G = 36500 \ m/yr$$

For Quiescent Lakes or Ponds

$$K_G = (C_d^{0.5} \cdot W) \cdot \frac{k^{0.33}}{\lambda_z} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot 3.1536 \times 10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-21	**K_G(river)[1]**	**m/yr**	**3.65E+04**	**--**
CALC: B-4-21	**K_G(pond)**	**m/yr**	4.06E+05	**--**
SITE SPECIFIC	**C_d[1]**	**unitless**	1.10E-03	**--**
SITE SPECIFIC	**W[1]**	**m/s**	3.90E+00	**--**
CONSTANT	**k[1]**	**unitless**	4.00E-01	**--**
SITE SPECIFIC	**λ_z[1]**	**unitless**	4.00E+00	**--**
SITE SPECIFIC	**μ_a[1]**	**g/cm-s**	1.81E-04	**--**
SITE SPECIFIC	**ρ_a[1]**	**g/cm^3**	1.20E-03	**--**
COPC SPECIFIC	**D_a[2]**	**cm^2/s**	6.00E-02	**--**

[1]Table B-4-21, pp. B-249 and B-250, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.
[2]Table 7, Section 6.5, Page 28, Deposition Parameterizations for the Industrial Source Complex (ISC3) June 2002.

TABLE B-4-22
BENTHIC BURIAL RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_b = \left(\frac{X_e \cdot A_L \cdot SD \cdot 1 \times 10^3 - Vf_x \cdot TSS}{A_w \cdot TSS} \right) \cdot \left(\frac{TSS \cdot 1 \times 10^{-6}}{C_{BS} \cdot d_{bs}} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-22	**k_b**	yr^{-1}	**5.908E-01**	--
CALC: B-4-13	**X_e**	kg/m^2-yr	2.29E+00	--
SITE SPECIFIC	**A_L**[1]	m^2	3.91E+09	--
CALC: B-4-14	**SD**	unitless	3.79E-02	--
SITE SPECIFIC	**Vf'_x**[2]	m^3/yr	1.35E+09	--
SITE SPECIFIC	**TSS**[3]	mg/L	1.63E+01	--
SITE SPECIFIC	**A_w**[4]	m^2	1.80E+07	--
SITE SPECIFIC	**C_{BS}**[5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	--

[1] A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[2] Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[3] Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[4] A_w, Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5] Table B-4-22, p. B-255, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-23
TOTAL WATER COLUMN CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{wctot} = f_{wc} \cdot C_{wtot} \cdot \frac{d_{wc} + d_{bs}}{d_{wc}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-23	C_{wctot}	mg/L	**3.864E-09**	--
CALC: B-4-16	f_{wc}	unitless	3.49E-03	--
CALC: B-4-15	C_{wtot}	mg/L	1.09E-06	--
SITE SPECIFIC	d_{wc}[1]	m	2.00E+00	--
SITE SPECIFIC	d_{bs}[2]	m	3.00E-02	--

[1]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[2]Table B-4-23, p. B-258, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-24
DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{dw} = \frac{C_{wctot}}{1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	mg/L	**1.25E-09**	**2.20E-10**
COPC SPECIFIC	% MeHg[1]	%	85.00%	15.00%
CALC: B-4-23	C_{wctot}	mg/L	3.86E-09	--
COPC SPECIFIC	Kd_{sw}[2]	L/kg SS	1.00E+05	--
SITE SPECIFIC	TSS[3]	mg/L	1.63E+01	--

[1]Divalent Mercury speciation split in the water body is assumed 85% Hg^{2+} and 15% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-27
FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF FISH EQUATIONS)

$$C_{fish} = C_{dw} \cdot BAF_{fish}$$

Concentration in fish based on the Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg fish tissue	**5.88E-04**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	mg/L	2.20E-10
COPC SPECIFIC	BAF_{fish}[1]	L/kg fish tissue	2.67E+06

[1]Table 1, Section 3.1.3.1.3, p. 21.,Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Median and Highest Background Concentration in Fish

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
SITE SPECIFIC	$C_{fish(median)}$[1]	mg/kg fish tissue	**8.90E-01**
SITE SPECIFIC	$C_{fish(highest)}$[1]	mg/kg fish tissue	**7.00E+00**

[1]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE B-5-1
AIR CONCENTRATION
(DIRECT INHALATION EQUATION)

$$C_a = Q_{(Hg0)} \cdot \left[Cyv F_v + (1 - F_v) \cdot Cyp \right]$$

For Elemental Mercury, F_v = 1.0, therefore:

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v \right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: B-5-1	**C_a**	μg/m^3	**1.52E-07**
SOURCE AND COPC SPECIFIC	**$Q_{(Hg0)}$**[1]	g/s	1.33E-05
COPC SPECIFIC	**F_v**[2]	unitless	1.00E+00
COPC AND SOURCE SPECIFIC	**Cyv**[3]	μg-s/g-m^3	1.14E-02

[1]Q(Hg0) = Q (total mercury) * 0.8% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2 of mercury deposition and risk assessment report.

[3]Unitized yearly air concentration from vapor phase from AERMOD Runs.

TABLE C-1-4
COPC INTAKE FROM FISH

$$I_{fish} = C_{fish} \cdot CR_{fish} \cdot F_{fish}$$

Intake Based on Proposed Pee Dee Facility Emissions

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	**5.18E-07**
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg	5.88E-04
EXPOSURE PARAMETER	$CR_{fish(subsistence\ fisher\ child)}$ [1]	kg/kg fish tissue-day	8.80E-04
SITE SPECIFIC	F_{fish} [2]	unitless	1.00E+00

[1]Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Intake Based on Median Background Concentration in the Little Pee Dee River [1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	**7.83E-04**
SITE SPECIFIC	$C_{fish(median)}$ [2]	mg/kg	8.90E-01

[1]I_{fish}, based on Subsistence Fisher Child consumption rate and F_{fish} = 1.0

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

Intake Based on Highest Background Concentration in the Little Pee Dee River [1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	**6.16E-03**
SITE SPECIFIC	$C_{fish(highest)}$ [2]	mg/kg	7.00E+00

[1]I_{fish}, based on Subsistence Fisher Child consumption rate and F_{fish} = 1.0

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE C-1-5
COPC INTAKE FROM DRINKING WATER

$$I_{dw} = \frac{C_{dw} \cdot CR_{dw} \cdot F_{dw}}{BW}$$

TYPE	COPC CAS NO. PARAMETERS	Methyl Mercury 22967-92-6
CALC: C-1-5	$I_{dw(Pee\ Dee)}$	**9.84E-12**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	2.20E-10
EXPOSURE PARAMETER	CR_{dw}[1]	6.70E-01
SITE SPECIFIC	F_{dw}[1]	1.00E+00
EXPOSURE PARAMETER	BW[1]	1.50E+01

[1]Table C-1-5, p. C-18, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE C-1-6
TOTAL DAILY INTAKE

$$I = I_{soil} + I_{ag} + I_{beef} + I_{milk} + I_{fish} + I_{pork} + I_{poultry} + I_{eggs} + I_{dw}$$

Intake Based on Emissions from Proposed Pee Dee Facility[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(Pee\ Dee)}$	mg/kg-day	**5.18E-07**
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	5.18E-07
CALC: C-1-5	I_{dw}[1]	mg/kg-day	9.84E-12

[1]I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Median Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(median)}$	mg/kg-day	**7.83E-04**
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	7.83E-04

[1]I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Highest Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(highest)}$	mg/kg-day	**6.16E-03**
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	6.16E-03

[1]I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

TABLE C-1-8
HAZARD QUOTIENT (INDEX) : NONCARCINOGENS[1]

$$HQ = \frac{I \cdot ED \cdot EF}{RfD \cdot AT \cdot 365}$$

[1]The Hazard Index (HI) is equal to Hazard Quotient (HQ) since methlymercury is the only COPC for which an HQ is calculated.

Impact Based on Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{subsistence\text{-}child(Pee\ Dee)}$**	unitless	**4.97E-03**
CALC: C-1-6	**$I_{(Pee\ Dee)}$**	mg/kg-day	5.18E-07
EXPOSURE PARAMETER	**ED[1]**	yr	6
EXPOSURE PARAMETER	**EF[1]**	days/yr	350
COPC SPECIFIC	**RfD[1]**	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT[1]**	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Median Background Concentration in Little Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{subsistence\ fisher\text{-}child(median)}$**	unitless	**7.51**
CALC: C-1-6	**$I_{(median)}$**	mg/kg-day	7.83E-04
EXPOSURE PARAMETER	**ED[1]**	yr	6
EXPOSURE PARAMETER	**EF[1]**	days/yr	350
COPC SPECIFIC	**RfD[1]**	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT[1]**	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Highest Background Concentration in Little Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{subsistence\ fisher\text{-}child(highest)}$**	unitless	**59.07**
CALC: C-1-6	**$I_{(highest)}$**	mg/kg-day	6.16E-03
EXPOSURE PARAMETER	**ED[1]**	yr	6
EXPOSURE PARAMETER	**EF[1]**	days/yr	350
COPC SPECIFIC	**RfD[1]**	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT[1]**	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

CUMULATIVE HAZARD QUOTIENT (INDEX): NONCARCINOGENS

Subsistence Fisher Child Scenario

TYPE	SOURCE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
INDIVIUAL	Proposed Pee Dee Facility Emissions	$HQ_{\text{subsistence fisher child (Pee Dee)}}$	unitless	4.97E-03
	Median Background Concentration	$HQ_{\text{subsistence fisher child (median)}}$	unitless	7.51
	Highest Background Concentration	$HQ_{\text{subsistence fisher child (highest)}}$	unitless	59.07
% CONTRIBUTION	Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	%	unitless	0.07%
	Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	%	unitless	0.01%

TABLE C-2-2
INHALATION HAZARD QUOTIENT

$$HQ_{inh(i)} = \frac{EC * 0.001}{RfC}$$

$$EC = \frac{C_a \cdot EF \cdot ED}{AT \cdot 365\ days/year}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: C-1-5	**$HQ_{(inh)}$**	unitless	**1.32E-07**
CALC: C-1-5	**EC**	µg/m^3	1.46E-07
EXPOSURE PARAMETER	**RfC[1]**	mg/m^3	1.10E-03
CALC: B-5-1	**C_a**	µg/m^3	1.52E-07
SITE SPECIFIC	**EF[2]**	days/yr	3.50E+02
EXPOSURE PARAMETER	**ED[2]**	yr	6.00E+00
EXPOSURE PARAMETER	**AT[2]**	yr	6.00E+00

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table C-2-2, pp. C-37 and C-38, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-1
WATERSHED SOIL CONCENTRATION DUE TO DEPOSITION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$Cs_{tD} = \frac{Ds \times \left(1 - \exp(-ks \cdot tD)\right)}{ks}$$

$$Ds = \frac{100 \cdot Q'_{(Hg2+)}}{Z_s \cdot BD} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	**1.92E-04**	**3.90E-06**
SITE- AND CONTAMINANT-SPECIFIC	**% MeHg**[1]	%	98%	2%
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
CALC: B-4-1	**D_s**	mg/kg soil-yr	**6.39E-06**	**1.30E-07**
COPC AND SOURCE SPECIFIC	**$Dytwv_{ws}$**[3]	s/m2-yr	8.58E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{ws}$**[3]	s/m2-yr	5.50E-04	--
COPC SPECIFIC	**F_v**[4]	unitless	9.90E-01	--
CALC: B-1-2	**ks**	yr^{-1}	2.052E-05	1.72E-04
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[5]	g/s	2.30E-04	--
SITE SPECIFIC	**tD**[2]	yr	3.00E+01	3.00E+01
SITE SPECIFIC	**Z_s**[2]	m	2.00E+01	2.00E+01

[1]Divalent Mercury speciation split in soils is assumed 98% Hg2+ and 2% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Table B-4-1, Appendix B, p. B-170 and p. B-172, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over watershed from AERMOD Model Runs.

[4]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[5]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes contriburtion from both Boilers (2*57.8 lbs = 115.6 lbs/yr).

TABLE B-4-2
COPC SOIL LOSS CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ks = ksg + kse + ksr + ksl + ksv$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-2	**ks**	yr^{-1}	**2.05E-05**	**1.72E-04**
COPC-SPECIFIC	**ksg**[1]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-3	**kse**[2]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-4	**ksr**	yr^{-1}	1.73E-05	1.43E-04
CALC: B-4-5	**ksl**	yr^{-1}	3.22E-06	2.67E-05
CALC: B-1-6	**ksv**	yr^{-1}	3.86E-10	1.86E-06

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]HHRAP recommended kse default value of zero for mercuric chloride, and methylmercury. Table B-4-2, Appendix B, p. B-177, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-3
COPC LOSS CONSTANT DUE TO SOIL EROSION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$kse = \frac{0.1 \cdot X_e \cdot SD \cdot ER}{BD \cdot Z_s} \cdot \left(\frac{Kd_s \cdot BD}{\theta_{sw} + (Kd_s \cdot BD)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-3	**kse**[1]	yr^{-1}	**0.00E+00**	**0.00E+00**
CALC: B-4-13	$\mathbf{X_e}$	kg/m^2-yr	-	-
CALC: B-4-14	**SD**	unitless	-	-
COPC SPECIFIC	**ER**	unitless	-	-
SITE SPECIFIC	**BD**	g soil/cm^3 soil	-	-
SITE SPECIFIC	$\mathbf{Z_s}$	cm	-	-
COPC SPECIFIC	$\mathbf{Kd_s}$	cm^3 water/g soil	-	-
SITE SPECIFIC	**θsw**	mL/cm^3 soil	-	-

[1] Consistent with U.S. EPA (1994), U.S. EPA (1994b), and NC DEHNR (1997), the HHRAP recommends that the default value assumed for kse is zero because contaminated soil erodes both onto the site and away from the site. Uncertainty may overestimate kse. Table B-4-3, Appendix B, p. B-180, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-4
COPC LOSS CONSTANT DUE TO RUNOFF
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksr = \frac{RO}{\theta_{sw} \cdot Z_s} \cdot \left(\frac{1}{1 + \left(Kd_s \cdot BD / \theta_{sw} \right)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-4	**ksr**	yr^{-1}	**1.73E-05**	**1.43E-04**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	**Z_s**[3]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]Table B-4-4, pp. B-186 and B-187, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Assumed Tilled soil, value based on Table B-4-4, pp. B-186, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-5
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksl = \frac{P + I - OR - E_v}{\theta_{sw} \cdot Z_s \cdot \left[1.0 + \left(BD \cdot Kd_s / \theta_{sw}\right)\right]}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-5	**ksl**	yr^{-1}	**3.22E-06**	**2.67E-05**
SITE SPECIFIC	**P**[1]	cm/yr	1.14E+02	1.14E+02
SITE SPECIFIC	**I**[2]	cm/yr	2.00E+01	2.00E+01
SITE SPECIFIC	**RO**[3]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	E_v[4]	cm/yr	9.83E+01	9.83E+01
SITE SPECIFIC	θ_{sw}[5]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	Z_s[5]	cm	2.00E+01	2.00E+01
SITE SPECIFIC	**BD**[5]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	Kd_s[6]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Monthly Stations Normals of Temperature, Precipitation and Heating and Cooling Degree Days (1971-2000) for South Carolina by Nationa Oceanic and Atmospheric Administration (Feburary 2002), the Florence RGNL AP Site was chosen (closest to Pee Dee Facility).

[2]Value derived using 2003 National Resources Inventory (NRI) -Annual Irrigation Input for Model Simulations. Value represents geospatial average across Pee Dee Watershed. (ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/croplandreport)

[3]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[4]Amatya, D. M., Trettin, C. 2007. Annual evapotranspiration of a forested wetland watershed, SC at ASABE Annual International Meeting, June 17 - 20, 2007, p. 16. (URL: http://asae.frymulti.com/abstract.asp?aid=22992&t=2)

[5]Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[6]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-6
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksv = \left[\frac{3.1536 \times 10^{7} \cdot H}{Z_s \cdot Kd_s \cdot R \cdot T_a \cdot BD}\right] \cdot \left(\frac{D_a}{Z_s}\right) \cdot \left[1 - \left(\frac{BD}{\rho_{soil}}\right) - \theta_{sw}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-6	**ksv**	yr^{-1}	**3.86E-10**	**1.86E-06**
COPC SPECIFIC	**H**[1]	atm-m^3/mol	7.10E-10	4.70E-07
SITE SPECIFIC	**Z_s**[2]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[1]	cm^3 water/g soil	5.80E+04	7.00E+03
CONSTANT	**R**[2]	atm-m^3/mol-K	8.21E-05	8.21E-05
SITE SPECIFIC	**T_a**[2]	K	2.98E+02	2.98E+02
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	**D_a**[1]	cm^2/s	6.00E-02	5.28E-02
SITE SPECIFIC	**ρ_{soil}**[2]	g/cm^3	2.70E+00	2.70E+00
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table B-4-6, pp. B-195, B-196 and B-197, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-7
TOTAL WATER BODY LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_T = L_{DEP} + L_{dif} + L_{RI} + L_R + L_E + L_{Dis}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-7	L_T	g/yr	**1.16E-02**	--
CALC: B-4-8	L_{DEP}	g/yr	7.91E-03	--
CALC: B-4-12	L_{dif}	g/yr	5.47E-05	--
CALC: B-4-9	L_{RI}	g/yr	7.91E-04	--
CALC: B-4-10	L_R	g/yr	3.98E-05	--
CALC: B-4-11	L_E	g/yr	2.80E-03	--
Wastewater Discharges	L_{Dis}[1]	g/yr	3.93E-01	--

[1]$L_{Dis} = C_{Dis} \times V_{Dis}$. Where, C_{Dis} (concentration of mercury in wastewater discharges) and V_{Dis} (proposed volumetric flow rate of the wastewater discharges). C_{Dis} and V_{Dis} have been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper. Original HHRAP equation modified to include the additional loading term L_{DIS}.

TABLE B-4-8
DEPOSITION TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L'_{DEP} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{wb} + (1 - F_v) \cdot Dytwp_{wb} \right] \cdot A_w$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-8	**L'_{DEP}**	g/yr	**7.91E-03**	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[1]	g/s	2.30E-04	--
COPC SPECIFIC	**F_v**[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Dytwv_{wb}$**[3]	s/m^2-yr	8.58E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{wb}$**[3]	s/m^2-yr	5.50E-04	--
SITE SPECIFIC	**A_w**[4]	m^2	4.05E+03	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{wb}$) and particle bound ($Dytwp_{wb}$) deposition over waterbody from AERMOD Model Runs.

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-9
IMPERVIOUS RUNOFF LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{RI} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right] \cdot A_I$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-9	$\mathbf{L_{RI}}$	g/yr	**7.91E-04**	--
COPC AND SOURCE SPECIFIC	$\mathbf{Q'_{(Hg2+)}}$ [1]	g/s	2.30E-04	--
COPC SPECIFIC	$\mathbf{F_v}$ [2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwv_{ws}}$ [3]	s/m^2-yr	8.58E-03	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwp_{ws}}$ [3]	s/m^2-yr	5.50E-04	--
SITE SPECIFIC	$\mathbf{A_I}$ [4]	m^2	4.05E+02	--

[1] Total Mercury Emissions from 2 Boilers (2*57.8 lbs = 115.6 lbs/yr), which includes the loss to global cycle.
[2] Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.
[3] Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over waterbody from AERMOD Model Runs.
[4] A_I, impervious surface area of watershed, calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

TABLE B-4-10
PERVIOUS RUNOFF LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_R = RO \cdot (A_L - A_I) \cdot \frac{Cs \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.01$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-10	**L_R**	g/yr	**3.981E-05**	**6.72E-06**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**A_L**[2]	m^2	4.05E+04	4.05E+04
SITE SPECIFIC	**A_I**[3]	m^2	4.05E+02	4.05E+02
CALC: B-4-1	**CstD**	mg/kg soil	1.92E-04	3.90E-06
SITE SPECIFIC	**BD**[4]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[4]	mL/cm^3 soil	2.00E-01	2.00E-01
COPC SPECIFIC	**Kd_s**[5]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[3]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

[4]Table B-4-10, p. B-208, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-11
EROSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_E = X_e \cdot (A_L - A_I) \cdot SD \cdot ER \cdot \frac{Cs \cdot Kd_s \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.001$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-11	L_E	g/yr	**2.80E-03**	**5.71E-05**
CALC: B-4-13	X_e	kg soil /m^2-yr	2.29E+00	2.29E+00
SITE SPECIFIC	A_L[1]	m^2	4.05E+04	4.05E+04
SITE SPECIFIC	A_I[2]	m^2	4.05E+02	4.05E+02
CALC: B-4-14	**SD**	unitless	1.59E-01	1.59E-01
SITE SPECIFIC	**ER**[3]	unitless	1.00E+00	1.00E+00
CALC: B-4-1	Cs_{tD}	mg/kg soil	1.92E-04	3.90E-06
COPC SPECIFIC	Kd_s[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[3]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	θ_{sw}[3]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).
[2]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.
[3]Table B-4-11, p. B-212, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.
[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-12
DIFFUSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{dif} = \frac{K_v \times Q'_{(Hg\,2+)} \times F_v \times Cyvw_{wb} \times A_w \times 1 \times 10^{-6}}{\dfrac{H}{R \times T_{wk}}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-12	**Ldif**	g/yr	**5.47E-05**	--
CALC: B-4-19	K_v	m/yr	1.21E-03	--
COPC AND SOURCE SPECIFIC	$Q'_{(Hg2+)}$ [1]	g/s	2.30E-04	--
COPC SPECIFIC	F_v [2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	$Cywv_{wb}$ [3]	µg-s/g-m^3	1.43E-03	--
SITE SPECIFIC	A_w [4]	m^2	4.05E+03	--
COPC SPECIFIC	H [5]	atm-m^3/mol	7.10E-10	--
CONSTANT	R [6]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	T_{wk} [6]	K	2.98E+02	--

[1] Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2] Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3] Yearly average air concentration from vapor phase (Cywv) over waterbody from AERMOD modeling runs

[4] Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5] Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[6] Table B-4-12, p. B-217, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-13
UNIVERSAL SOIL LOSS EQUATION (USLE)
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$X_e = RF \cdot K \cdot LS \cdot C \cdot PF \cdot \frac{907.18}{4047}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-13	**X_e**	kg/m^2-yr	**2.29E+00**	**--**
SITE SPECIFIC	**RF**[1]	yr^{-1}	1.75E+02	**--**
SITE SPECIFIC	**K**[2]	ton/acre	3.90E-01	**--**
SITE SPECIFIC	**LS**[2]	unitless	1.50E+00	**--**
SITE SPECIFIC	**C**[2]	unitless	1.00E-01	**--**
SITE SPECIFIC	**PF**[2]	unitless	1.00E+00	**--**

[1]USLE Rainfall Erosivity Factor - median of HHRAP recommended defaut range between 50-300.

[2]Table B-4-13, pp. B-219 and B-220, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-14
SEDIMENT DELIVERY RATIO
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$SD = a \cdot (A_L)^{-b}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-14	**SD**	unitless	**1.59E-01**	**--**
SITE SPECIFIC	**a**[1]	unitless	6.00E-01	**--**
SITE SPECIFIC	**A_L**[2]	m^2	4.05E+04	**--**
SITE SPECIFIC	**b**[1]	unitless	1.25E-01	**--**

[1]Table B-4-14, pp. B-223 and B-224, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-15
TOTAL WATER BODY CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C'_{wtot} = \frac{L'_T}{(Vf'_x + V_{Dis}) \times f_{wc} + k_{wt} \times A_w \times (d_{wc} + d_{bs})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-15	C'_{wtot}	g/m^3 (mg/L)	**1.16E-05**	--
CALC: B-4-7	L'_T	g/yr	1.16E-02	--
SITE SPECIFIC	Vf'_x [1]	m^3/yr	0.00E+00	--
SITE SPECIFIC	V_{Dis} [2]	m^3/yr	3.93E+06	
CALC: B-4-16	f_{wc}	unitless	3.49E-03	--
CALC: B-4-17	k_{wt}	yr^{-1}	1.21E-01	--
SITE SPECIFIC	A_w [3]	m^2	4.05E+03	--
SITE SPECIFIC	d_{wc} [4]	m	2.00E+00	--
SITE SPECIFIC	d_{bs} [5]	m	3.00E-02	--

[1]Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[2]V_{Dis}, proposed volumetric flow rate of the wastewater discharges and has been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper.

[3]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[4]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroelectric Project, FERC NO. 2206, Water Resources Work Group (April 30, 2004).

[5]Table B-4-15, p. B-228, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-16
FRACTION IN WATER COLUMN AND BENTHIC SEDIMENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$f_{wc} = \frac{(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}) \cdot d_{wc} / d_z}{(1 + Kd_{sw} \cdot TSS \cdot 1\times10^{-6}) \cdot d_{wc} / d_z + (\theta_{bs} + Kd_{bs} \cdot C_{BS}) \cdot d_{bs} / d_z}$$

$$f_{bs} = 1 - f_{wc}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-16	f_{wc}	unitless	**3.49E-03**	--
CALC: B-4-16	f_{bs}	unitless	**9.97E-01**	--
COPC SPECIFIC	Kd_{sw} [1]	L/kg SS	1.00E+05	--
SITE SPECIFIC	TSS[2]	mg/L	1.63E+01	--
SITE SPECIFIC	d_{wc} [3]	m	2.00E+00	--
SITE SPECIFIC	d_z [4]	m	2.03E+00	--
SITE SPECIFIC	θ_{bs} [5]	unitless	6.00E-01	--
COPC SPECIFIC	Kd_{bs} [1]	L / kg BS	5.00E+04	--
SITE SPECIFIC	C_{BS} [5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	d_{bs} [5]	m	3.00E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[3]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[4]d_z (Total water body depth) = d_{bs} + $d_{wc.}$

[5]Table B-4-16, pp. B-232 and B-233, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-17
OVERALL TOTAL WATER BODY DISSIPATION RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_{wt} = f_{wc} \cdot k_v + f_{bs} \cdot k_b$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-17	$\mathbf{k_{wt}}$	yr^{-1}	**1.21E-01**	--
CALC: B-4-16	$\mathbf{f_{wc}}$	unitless	3.49E-03	--
CALC: B-4-18	$\mathbf{k_v}$	yr^{-1}	2.26E-04	--
CALC: B-4-16	$\mathbf{f_{bs}}$	unitless	9.97E-01	--
CALC: B-4-22	$\mathbf{k_b}$	yr^{-1}	1.22E-01	--

TABLE B-4-18
WATER COLUMN VOLATILIZATION LOSS RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_v = \frac{K_v}{d_z \cdot (1 + Kd_{sw} \cdot TSS \cdot 10^{-6})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-18	k_v	yr^{-1}	**2.257E-04**	--
CALC: B-4-19	K_v	m/yr	1.21E-03	--
SITE SPECIFIC	d_z[1]	m	2.03E+00	--
COPC SPECIFIC	Kd_{sw}[2]	m	1.00E+05	--
SITE SPECIFIC	TSS[3]	m	1.63E+01	--

[1]d_z (Total water body depth) = d_{bs} + d_{wc}.
[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-19
OVERALL COPC TRANSFER RATE COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$K_v = \left[K_L^{-1} + \left(K_G \cdot \frac{H}{R \cdot T_{wk}} \right)^{-1} \right]^{-1} \cdot \theta^{(T_{wk} - 293)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-19	$\mathbf{K_v}$	m/yr	**1.21E-03**	--
CALC: B-4-20	$\mathbf{K_{L(river)}}$	m/yr	2.83E+02	--
CALC: B-4-21	$\mathbf{K_{G(river)}}$	m/yr	3.65E+04	--
COPC SPECIFIC	**H**[1]	atm-m^3/mol	7.10E-10	--
CONSTANT	**R**[2]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	$\mathbf{T_{wk}}$[2]	K	2.98E+02	--
SITE SPECIFIC	**θ**[2]	unitless	1.03E+00	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[2]Table B-4-19, p. B-243, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-20
LIQUID PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_L = \sqrt{\frac{(1 \times 10^{-4}) \cdot D_w \cdot u}{d_z}} \cdot 3.1536 \times 10^7$$

For Quiescent Lakes or Ponds

$$K_L = (C_d^{0.5} \cdot W) \cdot (\frac{\rho_a}{\rho_w})^{0.5} \cdot \frac{k^{0.33}}{\lambda_z} \cdot (\frac{\mu_w}{\rho_w \cdot D_w})^{-0.67} \cdot 3.1536 \times 10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-20	**K_L(river)**	m/yr	**2.83E+02**	--
CALC: B-4-20	**K_L(pond)**	m/yr	**1.17E+02**	--
COPC SPECIFIC	D_w[1]	cm^2/s	5.25E-06	--
SITE SPECIFIC	u[2]	m/s	3.11E-01	--
SITE SPECIFIC	d_z[3]	m	2.03E+00	--
SITE SPECIFIC	C_d[4]	unitless	1.10E-03	--
SITE SPECIFIC	W[4]	m/s	3.90E+00	--
SITE SPECIFIC	ρ_a[4]	g/cm^3	1.20E-03	--
SITE SPECIFIC	ρ_w[4]	g/cm^3	1.00E+00	--
CONSTANT	k[4]	unitless	4.00E-01	--
SITE SPECIFIC	λ_z[4]	unitless	4.00E+00	--
CONSTANT	μ_w[4]	g/cm-s	1.69E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Stream Velocity data (60 Day Average, Sep 15 - Nov 14) for USGS 02135200 Pee Dee River AT Hwy 701 NR Bucksport, SC
(URL: www.waterdata.usgs.gov).

[3]d_z (Total water body depth) = d_{bs} + $d_{wc.}$

[4]Table B-4-20, pp. B-246 and B-247, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-21
GAS PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_G = 36500 \ m/yr$$

For Quiescent Lakes or Ponds

$$K_G = (C_d^{0.5} \cdot W) \cdot \frac{k^{0.33}}{\lambda_z} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot 3.1536\times10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-21	**K_G(river)[1]**	**m/yr**	**3.65E+04**	**--**
CALC: B-4-21	**K_G(pond)**	**m/yr**	4.06E+05	**--**
SITE SPECIFIC	**C_d[1]**	**unitless**	1.10E-03	**--**
SITE SPECIFIC	**W[1]**	**m/s**	3.90E+00	**--**
CONSTANT	**k[1]**	**unitless**	4.00E-01	**--**
SITE SPECIFIC	**λ_z[1]**	**unitless**	4.00E+00	**--**
SITE SPECIFIC	**μ_a[1]**	**g/cm-s**	1.81E-04	**--**
SITE SPECIFIC	**ρ_a[1]**	**g/cm^3**	1.20E-03	**--**
COPC SPECIFIC	**D_a[2]**	**cm^2/s**	6.00E-02	**--**

[1]Table B-4-21, pp. B-249 and B-250, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005
[2]Table 7, Section 6.5, Page 28, Deposition Parameterizations for the Industrial Source Complex (ISC3) June 2002.

TABLE B-4-22
BENTHIC BURIAL RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_b = \left(\frac{X_e \cdot A_L \cdot SD \cdot 1 \times 10^3 - Vf_x \cdot TSS}{A_w \cdot TSS} \right) \cdot \left(\frac{TSS \cdot 1 \times 10^{-6}}{C_{BS} \cdot d_{bs}} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-22	k_b	yr^{-1}	**1.219E-01**	--
CALC: B-4-13	X_e	kg/m^2-yr	2.29E+00	--
SITE SPECIFIC	A_L[1]	m^2	4.05E+04	--
CALC: B-4-14	SD	unitless	1.59E-01	--
SITE SPECIFIC	Vf'_x[2]	m^3/yr	0.00E+00	--
SITE SPECIFIC	TSS[3]	mg/L	1.63E+01	--
SITE SPECIFIC	A_w[4]	m^2	4.05E+03	--
SITE SPECIFIC	C_{BS}[5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	d_{bs}[5]	m	3.00E-02	--

[1] A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[2] Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[3] Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[4] A_w, Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5] Table B-4-22, p. B-255, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-23
TOTAL WATER COLUMN CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{wctot} = f_{wc} \cdot C_{wtot} \cdot \frac{d_{wc} + d_{bs}}{d_{wc}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-23	C_{wctot}	mg/L	**4.125E-08**	--
CALC: B-4-16	f_{wc}	unitless	3.49E-03	--
CALC: B-4-15	C_{wtot}	mg/L	1.16E-05	--
SITE SPECIFIC	d_{wc}[1]	m	2.00E+00	--
SITE SPECIFIC	d_{bs}[2]	m	3.00E-02	--

[1]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).
[2]Table B-4-23, p. B-258, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-24
DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{dw} = \frac{C_{wctot}}{1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	mg/L	**1.33E-08**	**2.35E-09**
COPC SPECIFIC	% MeHg[1]	%	85.00%	15.00%
CALC: B-4-23	C_{wctot}	mg/L	4.12E-08	--
COPC SPECIFIC	Kd_{sw}[2]	L/kg SS	1.00E+05	--
SITE SPECIFIC	TSS[3]	mg/L	1.63E+01	--

[1]Divalent Mercury speciation split in the water body is assumed 85% Hg^{2+} and 15% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-27
FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF FISH EQUATIONS)

$$C_{fish} = C_{dw} \cdot BAF_{fish}$$

Concentration in fish based on the Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: B-4-27	$\mathbf{C_{fish(Pee\ Dee)}}$	mg/kg fish tissue	**6.28E-03**
CALC: B-4-24	$\mathbf{C_{dw(Pee\ Dee)}}$	mg/L	2.35E-09
COPC SPECIFIC	$\mathbf{BAF_{fish}}$[1]	L/kg fish tissue	2.67E+06

[1]Table 1, Section 3.1.3.1.3, p. 21.,Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Median and Highest Background Concentration in Fish

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
SITE SPECIFIC	$\mathbf{C_{fish(median)}}$[1]	mg/kg fish tissue	**8.90E-01**
SITE SPECIFIC	$\mathbf{C_{fish(highest)}}$[1]	mg/kg fish tissue	**7.00E+00**

[1]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE B-5-1
AIR CONCENTRATION
(DIRECT INHALATION EQUATION)

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v + (1 - F_v) \cdot Cyp \right]$$

For Elemental Mercury, F_v = 1.0, therefore:

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v \right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: B-5-1	**C_a**	µg/m^3	**1.52E-07**
SOURCE AND COPC SPECIFIC	**$Q_{(Hg0)}$**[1]	g/s	1.33E-05
COPC SPECIFIC	**F_v**[2]	unitless	1.00E+00
COPC AND SOURCE SPECIFIC	**Cyv**[3]	µg-s/g-m^3	1.14E-02

[1]Q(Hg0) = Q (total mercury) * 0.8% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2 of mercury deposition and risk assessment report.

[3]Unitized yearly air concentration from vapor phase from AERMOD Runs.

TABLE C-1-4
COPC INTAKE FROM FISH

$$I_{fish} = C_{fish} \cdot CR_{fish} \cdot F_{fish}$$

Intake Based on Proposed Pee Dee Facility Emissions

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	**7.85E-06**
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg	6.28E-03
EXPOSURE PARAMETER	$CR_{fish(subsistence\ fisher\ adult)}$ [1]	kg/kg fish tissue-day	1.25E-03
SITE SPECIFIC	F_{fish} [1]	unitless	1.00E+00

[1]Table C-1-4, p. C-15, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Intake Based on Median Background Concentration in Pee Dee River [1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	**1.11E-03**
SITE SPECIFIC	$C_{fish(median)}$ [2]	mg/kg	8.90E-01

[1]I_{fish}, based on Subsistence Fisher Adult consumption rate and F_{fish} = 1.0

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

Intake Based on Highest Background Concentration in Pee Dee River [1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	**8.75E-03**
SITE SPECIFIC	$C_{fish(highest)}$ [2]	mg/kg	7.00E+00

[1]I_{fish}, based on Subsistence Fisher Adult consumption rate and F_{fish} = 1.0

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE C-1-5
COPC INTAKE FROM DRINKING WATER

$$I_{dw} = \frac{C_{dw} \cdot CR_{dw} \cdot F_{dw}}{BW}$$

TYPE	COPC CAS NO. PARAMETERS	Methyl Mercury 22967-92-6
CALC: C-1-5	$I_{dw(Pee\ Dee)}$	**4.70E-11**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	2.35E-09
EXPOSURE PARAMETER	CR_{dw}[1]	1.40E+00
SITE SPECIFIC	F_{dw}[1]	1.00E+00
EXPOSURE PARAMETER	BW[1]	7.00E+01

[1]Table C-1-5, p. C-18, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE C-1-6
TOTAL DAILY INTAKE

$$I = I_{soil} + I_{ag} + I_{beef} + I_{milk} + I_{fish} + I_{pork} + I_{poultry} + I_{eggs} + I_{dw}$$

Intake Based on Emissions from Proposed Pee Dee Facility[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(Pee\ Dee)}$	mg/kg-day	**7.85E-06**
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	7.85E-06
CALC: C-1-5	I_{dw}[1]	mg/kg-day	4.70E-11

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Median Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(median)}$	mg/kg-day	**1.11E-03**
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	1.11E-03

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Highest Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(highest)}$	mg/kg-day	**8.75E-03**
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	8.75E-03

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

TABLE C-1-8
HAZARD QUOTIENT (INDEX) : NONCARCINOGENS[1]

$$HQ = \frac{I \cdot ED \cdot EF}{RfD \cdot AT \cdot 365}$$

[1]The Hazard Index (HI) is equal to Hazard Quotient (HQ) since methlymercury is the only COPC for which an HQ is calculated.

Impact Based on Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{\text{subsistence fisher adult (Pee Dee)}}$**	unitless	**7.53E-02**
CALC: C-1-6	**$I_{\text{(Pee Dee)}}$**	mg/kg-day	7.85E-06
EXPOSURE PARAMETER	**ED[1]**	yr	30
EXPOSURE PARAMETER	**EF[1]**	days/yr	350
COPC SPECIFIC	**RfD[1]**	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT[1]**	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Median Background Concentration in Great Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{\text{subsistence fisher adult (median)}}$**	unitless	**10.67**
CALC: C-1-6	**$I_{\text{(median)}}$**	mg/kg-day	1.11E-03
EXPOSURE PARAMETER	**ED[1]**	yr	30
EXPOSURE PARAMETER	**EF[1]**	days/yr	350
COPC SPECIFIC	**RfD[1]**	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT[1]**	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Highest Background Concentration in Great Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	**$HQ_{\text{subsistence fisher adult (highest)}}$**	unitless	**83.90**
CALC: C-1-6	**$I_{\text{(highest)}}$**	mg/kg-day	8.75E-03
EXPOSURE PARAMETER	**ED[1]**	yr	30
EXPOSURE PARAMETER	**EF[1]**	days/yr	350
COPC SPECIFIC	**RfD[1]**	mg/kg-day	0.0001
EXPOSURE PARAMETER	**AT[1]**	yr	30

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

CUMULATIVE HAZARD QUOTIENT (INDEX): NONCARCINOGENS

Subsistence Fisher Adult (Lake Scenario)

TYPE	SOURCE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
INDIVIUAL	**Proposed Pee Dee Facility Emissions**	$HQ_{\text{subsistence fisher adult (Pee Dee)}}$	unitless	**7.53E-02**
	Median Background Concentration	$HQ_{\text{subsistence fisher adult (median)}}$	unitless	**10.67**
	Highest Background Concentration	$HQ_{\text{subsistence fisher adult (highest)}}$	unitless	**83.90**
% CONTRIBUTION	**Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)**	%	unitless	**0.70%**
	Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	%	unitless	**0.09%**

TABLE C-2-2
INHALATION HAZARD QUOTIENT

$$HQ_{inh(i)} = \frac{EC * 0.001}{RfC}$$

$$EC = \frac{C_a \cdot EF \cdot ED}{AT \cdot 365\ days/year}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: C-1-5	**$HQ_{(inh)}$**	unitless	**1.32E-07**
CALC: C-1-5	**EC**	$\mu g/m^3$	1.46E-07
EXPOSURE PARAMETER	**RfC**[1]	mg/m^3	1.10E-03
CALC: B-5-1	**C_a**	$\mu g/m^3$	1.52E-07
SITE SPECIFIC	**EF**[2]	days/yr	3.50E+02
EXPOSURE PARAMETER	**ED**[2]	yr	3.00E+01
EXPOSURE PARAMETER	**AT**[2]	yr	3.00E+01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table C-2-2, pp. C-37 and C-38, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-1
WATERSHED SOIL CONCENTRATION DUE TO DEPOSITION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$Cs_{tD} = \frac{Ds \times \left(1 - \exp(-ks \cdot tD)\right)}{ks}$$

$$Ds = \frac{100 \cdot Q'_{(Hg2+)}}{Z_s \cdot BD} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	**1.92E-04**	**3.90E-06**
SITE- AND CONTAMINANT-SPECIFIC	**% MeHg**[1]	%	98%	2%
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
CALC: B-4-1	**D_s**	mg/kg soil-yr	**6.39E-06**	**1.30E-07**
COPC AND SOURCE SPECIFIC	**$Dytwv_{ws}$**[3]	s/m2-yr	8.58E-03	--
COPC AND SOURCE SPECIFIC	**$Dytwp_{ws}$**[3]	s/m2-yr	5.50E-04	--
COPC SPECIFIC	**F_v**[4]	unitless	9.90E-01	--
CALC: B-1-2	**ks**	yr^{-1}	2.052E-05	1.72E-04
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[5]	g/s	2.30E-04	--
SITE SPECIFIC	**tD**[2]	yr	3.00E+01	3.00E+01
SITE SPECIFIC	**Z_s**[2]	m	2.00E+01	2.00E+01

[1]Divalent Mercury speciation split in soils is assumed 98% Hg2+ and 2% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Table B-4-1, Appendix B, p. B-170 and p. B-172, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over watershed from AERMOD Model Runs.

[4]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[5]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes contriburtion from both Boilers (2*57.8 lbs = 115.6 lbs/yr).

TABLE B-4-2
COPC SOIL LOSS CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ks = ksg + kse + ksr + ksl + ksv$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-2	**ks**	yr^{-1}	**2.05E-05**	**1.72E-04**
COPC-SPECIFIC	**ksg**[1]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-3	**kse**[2]	yr^{-1}	0.00E+00	0.00E+00
CALC: B-4-4	**ksr**	yr^{-1}	1.73E-05	1.43E-04
CALC: B-4-5	**ksl**	yr^{-1}	3.22E-06	2.67E-05
CALC: B-1-6	**ksv**	yr^{-1}	3.86E-10	1.86E-06

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]HHRAP recommended kse default value of zero for mercuric chloride, and methylmercury. Table B-4-2, Appendix B, p. B-177, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-3
COPC LOSS CONSTANT DUE TO SOIL EROSION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$kse = \frac{0.1 \cdot X_e \cdot SD \cdot ER}{BD \cdot Z_s} \left(\frac{Kd_s \cdot BD}{\theta_{sw} + (Kd_s \cdot BD)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-3	**kse**[1]	yr^{-1}	**0.00E+00**	**0.00E+00**
CALC: B-4-13	**X_e**	kg/m^2-yr	-	-
CALC: B-4-14	**SD**	unitless	-	-
COPC SPECIFIC	**ER**	unitless	-	-
SITE SPECIFIC	**BD**	g soil/cm^3 soil	-	-
SITE SPECIFIC	**Z_s**	cm	-	-
COPC SPECIFIC	**Kd_s**	cm^3 water/g soil	-	-
SITE SPECIFIC	**θsw**	mL/cm^3 soil	-	-

[1] Consistent with U.S. EPA (1994), U.S. EPA (1994b), and NC DEHNR (1997), the HHRAP recommends that the default value assumed for kse is zero because contaminated soil erodes both onto the site and away from the site. Uncertainty may overestimate kse. Table B-4-3, Appendix B, p. B-180, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-4
COPC LOSS CONSTANT DUE TO RUNOFF
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksr = \frac{RO}{\theta_{sw} \cdot Z_s} \cdot \left(\frac{1}{1 + \left(Kd_s \cdot BD / \theta_{sw} \right)} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-4	**ksr**	yr^{-1}	**1.73E-05**	**1.43E-04**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	$\boldsymbol{\theta_{sw}}$[2]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	$\boldsymbol{Z_s}$[3]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	$\boldsymbol{Kd_s}$[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]Table B-4-4, pp. B-186 and B-187, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[3]Assumed Tilled soil, value based on Table B-4-4, pp. B-186, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[4]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-5
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksl = \frac{P + I - OR - E_v}{\theta_{sw} \cdot Z_s \cdot \left[1.0 + \left(BD \cdot Kd_s / \theta_{sw}\right)\right]}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-5	**ksl**	yr^{-1}	**3.22E-06**	**2.67E-05**
SITE SPECIFIC	**P**[1]	cm/yr	1.14E+02	1.14E+02
SITE SPECIFIC	**I**[2]	cm/yr	2.00E+01	2.00E+01
SITE SPECIFIC	**RO**[3]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	E_v[4]	cm/yr	9.83E+01	9.83E+01
SITE SPECIFIC	θ_{sw}[5]	mL/cm^3 soil	2.00E-01	2.00E-01
SITE SPECIFIC	Z_s[5]	cm	2.00E+01	2.00E+01
SITE SPECIFIC	**BD**[5]	g $soil/cm^3$ soil	1.50E+00	1.50E+00
COPC SPECIFIC	Kd_s[6]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Monthly Stations Normals of Temperature, Precipitation and Heating and Cooling Degree Days (1971-2000) for South Carolina by Nationa Oceanic and Atmospheric Administration (Feburary 2002), the Florence RGNL AP Site was chosen (closest to Pee Dee Facility).

[2]Value derived using 2003 National Resources Inventory (NRI) -Annual Irrigation Input for Model Simulations. Value represents geospatial average across Pee Dee Watershed. (ftp://ftp-fc.sc.egov.usda.gov/NHQ/nri/ceap/croplandreport)

[3]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[4]Amatya, D. M., Trettin, C. 2007. Annual evapotranspiration of a forested wetland watershed, SC at ASABE Annual International Meeting, June 17 - 20, 2007, p. 16. (URL: http://asae.frymulti.com/abstract.asp?aid=22992&t=2)

[5]Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[6]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-6
COPC LOSS CONSTANT DUE TO LEACHING
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$ksv = \left[\frac{3.1536 \times 10^{7} \cdot H}{Z_s \cdot Kd_s \cdot R \cdot T_a \cdot BD}\right] \cdot \left(\frac{D_a}{Z_s}\right) \cdot \left[1 - \left(\frac{BD}{\rho_{soil}}\right) - \theta_{sw}\right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-6	**ksv**	yr^{-1}	**3.86E-10**	**1.86E-06**
COPC SPECIFIC	**H**[1]	$atm\text{-}m^3/mol$	7.10E-10	4.70E-07
SITE SPECIFIC	**Z_s**[2]	cm	2.00E+01	2.00E+01
COPC SPECIFIC	**Kd_s**[1]	cm^3 water/g soil	5.80E+04	7.00E+03
CONSTANT	**R**[2]	$atm\text{-}m^3/mol\text{-}K$	8.21E-05	8.21E-05
SITE SPECIFIC	**T_a**[2]	K	2.98E+02	2.98E+02
SITE SPECIFIC	**BD**[2]	g soil/cm^3 soil	1.50E+00	1.50E+00
COPC SPECIFIC	**D_a**[1]	cm^2/s	6.00E-02	5.28E-02
SITE SPECIFIC	**ρ_{soil}**[2]	g/cm^3	2.70E+00	2.70E+00
SITE SPECIFIC	**θ_{sw}**[2]	mL/cm^3 soil	2.00E-01	2.00E-01

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table B-4-6, pp. B-195, B-196 and B-197, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-7
TOTAL WATER BODY LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_T = L_{DEP} + L_{dif} + L_{RI} + L_R + L_E + L_{Dis}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-7	L_T	g/yr	**1.16E-02**	--
CALC: B-4-8	L_{DEP}	g/yr	7.91E-03	--
CALC: B-4-12	L_{dif}	g/yr	5.47E-05	--
CALC: B-4-9	L_{RI}	g/yr	7.91E-04	--
CALC: B-4-10	L_R	g/yr	3.98E-05	--
CALC: B-4-11	L_E	g/yr	2.80E-03	--
Wastewater Discharges	L_{Dis}[1]	g/yr	3.93E-01	--

[1]$L_{Dis} = C_{Dis} \times V_{Dis}$. Where, C_{Dis} (concentration of mercury in wastewater discharges) and V_{Dis} (proposed volumetric flow rate of the wastewater discharges). C_{Dis} and V_{Dis} have been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper. Original HHRAP equation modified to include the additional loading term $L_{DIS.}$

TABLE B-4-8
DEPOSITION TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L'_{DEP} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{wb} + \left(1 - F_v\right) \cdot Dytwp_{wb}\right] \cdot A_w$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-8	**L'_{DEP}**	g/yr	**7.91E-03**	**--**
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$** [1]	g/s	2.30E-04	**--**
COPC SPECIFIC	**F_v** [2]	unitless	9.90E-01	**--**
COPC AND SOURCE SPECIFIC	**$Dytwv_{wb}$** [3]	s/m^2-yr	8.58E-03	**--**
COPC AND SOURCE SPECIFIC	**$Dytwp_{wb}$** [3]	s/m^2-yr	5.50E-04	**--**
SITE SPECIFIC	**A_w** [4]	m^2	4.05E+03	**--**

[1] Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2] Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3] Total (wet and dry) unitized yearly vapor phase ($Dytwv_{wb}$) and particle bound ($Dytwp_{wb}$) deposition over waterbody from AERMOD Model Runs.

[4] Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-9
IMPERVIOUS RUNOFF LOAD
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{RI} = Q'_{(Hg\,2+)} \cdot \left[F_v \cdot Dytwv_{ws} + \left(1 - F_v\right) \cdot Dytwp_{ws}\right] \cdot A_I$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-9	$\mathbf{L_{RI}}$	g/yr	**7.91E-04**	--
COPC AND SOURCE SPECIFIC	$\mathbf{Q'_{(Hg2+)}}$[1]	g/s	2.30E-04	--
COPC SPECIFIC	$\mathbf{F_v}$[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwv_{ws}}$[3]	s/m^2-yr	8.58E-03	--
COPC AND SOURCE SPECIFIC	$\mathbf{Dytwp_{ws}}$[3]	s/m^2-yr	5.50E-04	--
SITE SPECIFIC	$\mathbf{A_I}$[4]	m^2	4.05E+02	--

[1]Total Mercury Emissions from 2 Boilers (2*57.8 lbs = 115.6 lbs/yr), which includes the loss to global cycle
[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.
[3]Total (wet and dry) unitized yearly vapor phase ($Dytwv_{ws}$) and particle bound ($Dytwp_{ws}$) deposition over waterbody from AERMOD Model Runs.
[4]A_I, impervious surface area of watershed, calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

TABLE B-4-10
PERVIOUS RUNOFF LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_R = RO \cdot (A_L - A_I) \cdot \frac{Cs \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.01$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-10	**L_R**	g/yr	**3.981E-05**	**6.72E-06**
SITE SPECIFIC	**RO**[1]	cm/yr	3.01E+01	3.01E+01
SITE SPECIFIC	**A_L**[2]	m^2	4.05E+04	4.05E+04
SITE SPECIFIC	**A_I**[3]	m^2	4.05E+02	4.05E+02
CALC: B-4-1	**CstD**	mg/kg soil	1.92E-04	3.90E-06
SITE SPECIFIC	**BD**[4]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[4]	mL/cm^3 soil	2.00E-01	2.00E-01
COPC SPECIFIC	**Kd_s**[5]	cm^3 water/g soil	5.80E+04	7.00E+03

[1]Measured mean annual runoff from Climate Research Vol. 11: 149-159, 1999 (http://www.int-res.com/articles/cr/11/c011p149.pdf)

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[3]A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

[4]Table B-4-10, p. B-208, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-11
EROSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_E = X_e \cdot (A_L - A_I) \cdot SD \cdot ER \cdot \frac{Cs \cdot Kd_s \cdot BD}{\theta_{sw} + Kd_s \cdot BD} \cdot 0.001$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-11	**L_E**	g/yr	**2.80E-03**	**5.71E-05**
CALC: B-4-13	**X_e**	kg soil /m^2-yr	2.29E+00	2.29E+00
SITE SPECIFIC	**A_L**[1]	m^2	4.05E+04	4.05E+04
SITE SPECIFIC	**A_I**[2]	m^2	4.05E+02	4.05E+02
CALC: B-4-14	**SD**	unitless	1.59E-01	1.59E-01
SITE SPECIFIC	**ER**[3]	unitless	1.00E+00	1.00E+00
CALC: B-4-1	**Cs_{tD}**	mg/kg soil	1.92E-04	3.90E-06
COPC SPECIFIC	**Kd_s**[4]	cm^3 water/g soil	5.80E+04	7.00E+03
SITE SPECIFIC	**BD**[3]	g soil/cm^3 soil	1.50E+00	1.50E+00
SITE SPECIFIC	**θ_{sw}**[3]	mL/cm^3 soil	2.00E-01	2.00E-01

[1] A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[2] A_I, impervious surface area of watershed (m^2), calculated as 1% of the total watershed area based on 2001 NLCD percent impervious area within defined effective watershed.

[3] Table B-4-11, p. B-212, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[4] Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

TABLE B-4-12
DIFFUSION LOAD TO WATER BODY
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$L_{dif} = \frac{K_v \times Q'_{(Hg2+)} \times F_v \times Cyvw_{wb} \times A_w \times 1 \times 10^{-6}}{\frac{H}{R \times T_{wk}}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-12	**Ldif**	g/yr	**5.47E-05**	--
CALC: B-4-19	**K_v**	m/yr	1.21E-03	--
COPC AND SOURCE SPECIFIC	**$Q'_{(Hg2+)}$**[1]	g/s	2.30E-04	--
COPC SPECIFIC	**F_v**[2]	unitless	9.90E-01	--
COPC AND SOURCE SPECIFIC	**$Cywv_{wb}$**[3]	µg-s/g-m^3	1.43E-03	--
SITE SPECIFIC	**A_w**[4]	m^2	4.05E+03	--
COPC SPECIFIC	**H**[5]	atm-m^3/mol	7.10E-10	--
CONSTANT	**R**[6]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	**T_{wk}**[6]	K	2.98E+02	--

[1]Q(Hg2+) = Q (total mercury) * 13.77% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes loss to global mercury cycle, based on Figure 2-1, Section 2.2.2, Page 2-2 of report.

[3]Yearly average air concentration from vapor phase (Cywv) over waterbody from AERMOD modeling runs

[4]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[6]Table B-4-12, p. B-217, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-13
UNIVERSAL SOIL LOSS EQUATION (USLE)
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$X_e = RF \cdot K \cdot LS \cdot C \cdot PF \cdot \frac{907.18}{4047}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-13	**X_e**	kg/m^2-yr	**2.29E+00**	--
SITE SPECIFIC	**RF**[1]	yr^{-1}	1.75E+02	--
SITE SPECIFIC	**K**[2]	ton/acre	3.90E-01	--
SITE SPECIFIC	**LS**[2]	unitless	1.50E+00	--
SITE SPECIFIC	**C**[2]	unitless	1.00E-01	--
SITE SPECIFIC	**PF**[2]	unitless	1.00E+00	--

[1]USLE Rainfall Erosivity Factor - median of HHRAP recommended defaut range between 50-300.

[2]Table B-4-13, pp. B-219 and B-220, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-14
SEDIMENT DELIVERY RATIO
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$SD = a \cdot (A_L)^{-b}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-14	**SD**	unitless	**1.59E-01**	**--**
SITE SPECIFIC	**a**[1]	unitless	6.00E-01	**--**
SITE SPECIFIC	**A_L**[2]	m^2	4.05E+04	**--**
SITE SPECIFIC	**b**[1]	unitless	1.25E-01	**--**

[1]Table B-4-14, pp. B-223 and B-224, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

TABLE B-4-15
TOTAL WATER BODY CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C'_{wtot} = \frac{L'_T}{(Vf'_x + V_{Dis}) \times f_{wc} + k_{wt} \times A_w \times (d_{wc} + d_{bs})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-15	**C'_{wtot}**	g/m^3 (mg/L)	**1.16E-05**	--
CALC: B-4-7	**L'_T**	g/yr	1.16E-02	--
SITE SPECIFIC	**Vf'_x**[1]	m^3/yr	0.00E+00	--
SITE SPECIFIC	**V_{Dis}**[2]	m^3/yr	3.93E+06	
CALC: B-4-16	**f_{wc}**	unitless	3.49E-03	--
CALC: B-4-17	**k_{wt}**	yr^{-1}	1.21E-01	--
SITE SPECIFIC	**A_w**[3]	m^2	4.05E+03	--
SITE SPECIFIC	**d_{wc}**[4]	m	2.00E+00	--
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	--

[1]Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[2]V_{Dis}, proposed volumetric flow rate of the wastewater discharges and has been adopted from MACTEC Engineering and Consulting, Inc., Draft Environmental Assessment – Santee Cooper Pee Dee Electrical Generating Station, October 2006, prepared for Santee Cooper.

[3]Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[4]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroelectric Project, FERC NO. 2206, Water Resources Work Group (April 30, 2004).

[5]Table B-4-15, p. B-228, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-16
FRACTION IN WATER COLUMN AND BENTHIC SEDIMENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$f_{wc} = \frac{(1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}) \cdot d_{wc} / d_z}{(1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}) \cdot d_{wc} / d_z + (\theta_{bs} + Kd_{bs} \cdot C_{BS}) \cdot d_{bs} / d_z}$$

$$f_{bs} = 1 - f_{wc}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-16	**f_{wc}**	unitless	**3.49E-03**	**--**
CALC: B-4-16	**f_{bs}**	unitless	**9.97E-01**	**--**
COPC SPECIFIC	**Kd_{sw}**[1]	L/kg SS	1.00E+05	**--**
SITE SPECIFIC	**TSS**[2]	mg/L	1.63E+01	**--**
SITE SPECIFIC	**d_{wc}**[3]	m	2.00E+00	**--**
SITE SPECIFIC	**d_z**[4]	m	2.03E+00	**--**
SITE SPECIFIC	**θ_{bs}**[5]	unitless	6.00E-01	**--**
COPC SPECIFIC	**Kd_{bs}**[1]	L / kg BS	5.00E+04	**--**
SITE SPECIFIC	**C_{BS}**[5]	g/cm^3	1.00E+00	**--**
SITE SPECIFIC	**d_{bs}**[5]	m	3.00E-02	**--**

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[3]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).

[4]d_z (Total water body depth) = d_{bs} + d_{wc}.

[5]Table B-4-16, pp. B-232 and B-233, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-17
OVERALL TOTAL WATER BODY DISSIPATION RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_{wt} = f_{wc} \cdot k_v + f_{bs} \cdot k_b$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-17	**k_{wt}**	yr^{-1}	**1.21E-01**	--
CALC: B-4-16	**f_{wc}**	unitless	3.49E-03	--
CALC: B-4-18	**k_v**	yr^{-1}	2.26E-04	--
CALC: B-4-16	**f_{bs}**	unitless	9.97E-01	--
CALC: B-4-22	**k_b**	yr^{-1}	1.22E-01	--

TABLE B-4-18
WATER COLUMN VOLATILIZATION LOSS RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_v = \frac{K_v}{d_z \cdot (1 + Kd_{sw} \cdot TSS \cdot 10^{-6})}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-18	$\mathbf{k_v}$	yr^{-1}	**2.257E-04**	--
CALC: B-4-19	$\mathbf{K_v}$	m/yr	1.21E-03	--
SITE SPECIFIC	$\mathbf{d_z}$[1]	m	2.03E+00	--
COPC SPECIFIC	$\mathbf{Kd_{sw}}$[2]	m	1.00E+05	--
SITE SPECIFIC	**TSS**[3]	m	1.63E+01	--

[1] d_z (Total water body depth) = d_{bs} + $d_{wc.}$
[2] Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[3] Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-19
OVERALL COPC TRANSFER RATE COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$K_v = \left[K_L^{-1} + \left(K_G \cdot \frac{H}{R \cdot T_{wk}} \right)^{-1} \right]^{-1} \cdot \theta^{(T_{wk} - 293)}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-19	**K_v**	m/yr	**1.21E-03**	--
CALC: B-4-20	**K_L**	m/yr	2.83E+02	--
CALC: B-4-21	**K_G**	m/yr	3.65E+04	--
COPC SPECIFIC	**H**[1]	atm-m^3/mol	7.10E-10	--
CONSTANT	**R**[2]	atm-m^3/mol-K	8.21E-05	--
SITE SPECIFIC	**T_{wk}**[2]	K	2.98E+02	--
SITE SPECIFIC	**θ**[2]	unitless	1.03E+00	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).
[2]Table B-4-19, p. B-243, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-20
LIQUID PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_L = \sqrt{\frac{(1 \times 10^{-4}) \cdot D_w \cdot u}{d_z}} \cdot 3.1536 \times 10^7$$

For Quiescent Lakes or Ponds

$$K_L = (C_d^{0.5} \cdot W) \cdot (\frac{\rho_a}{\rho_w})^{0.5} \cdot \frac{k^{0.33}}{\lambda_z} \cdot (\frac{\mu_w}{\rho_w \cdot D_w})^{-0.67} \cdot 3.1536 \times 10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-20	**K_L(river)**	m/yr	**2.83E+02**	--
CALC: B-4-20	**K_L(pond)**	m/yr	**1.17E+02**	--
COPC SPECIFIC	**D_w**[1]	cm^2/s	5.25E-06	--
SITE SPECIFIC	**u**[2]	m/s	3.11E-01	--
SITE SPECIFIC	**d_z**[3]	m	2.03E+00	--
SITE SPECIFIC	**C_d**[4]	unitless	1.10E-03	--
SITE SPECIFIC	**W**[4]	m/s	3.90E+00	--
SITE SPECIFIC	**ρ_a**[4]	g/cm^3	1.20E-03	--
SITE SPECIFIC	**ρ_w**[4]	g/cm^3	1.00E+00	--
CONSTANT	**k**[4]	unitless	4.00E-01	--
SITE SPECIFIC	**λ_z**[4]	unitless	4.00E+00	--
CONSTANT	**μ_w**[4]	g/cm-s	1.69E-02	--

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury
(URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Stream Velocity data (60 Day Average, Sep 15 - Nov 14) for USGS 02135200 Pee Dee River AT Hwy 701 NR Bucksport, SC
(URL: www.waterdata.usgs.gov).

[3]d_z (Total water body depth) = d_{bs} + d_{wc}.

[4]Table B-4-20, pp. B-246 and B-247, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-21
GAS PHASE TRANSFER COEFFICIENT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

For Flowing Streams or Rivers

$$K_G = 36500 \ m/yr$$

For Quiescent Lakes or Ponds

$$K_G = (C_d^{0.5} \cdot W) \cdot \frac{k^{0.33}}{\lambda_z} \cdot \left(\frac{\mu_a}{\rho_a \cdot D_a}\right)^{-0.67} \cdot 3.1536\times10^7$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-21	**K_G(river)[1]**	**m/yr**	**3.65E+04**	**--**
CALC: B-4-21	**K_G(pond)**	**m/yr**	4.06E+05	**--**
SITE SPECIFIC	**C_d[1]**	**unitless**	1.10E-03	**--**
SITE SPECIFIC	**W[1]**	**m/s**	3.90E+00	**--**
CONSTANT	**k[1]**	**unitless**	4.00E-01	**--**
SITE SPECIFIC	**λ_z[1]**	**unitless**	4.00E+00	**--**
SITE SPECIFIC	**μ_a[1]**	**g/cm-s**	1.81E-04	**--**
SITE SPECIFIC	**ρ_a[1]**	**g/cm^3**	1.20E-03	**--**
COPC SPECIFIC	**D_a[2]**	**cm^2/s**	6.00E-02	**--**

[1]Table B-4-21, pp. B-249 and B-250, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005
[2]Table 7, Section 6.5, Page 28, Deposition Parameterizations for the Industrial Source Complex (ISC3) June 2002.

TABLE B-4-22
BENTHIC BURIAL RATE CONSTANT
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$k_b = \left(\frac{X_e \cdot A_L \cdot SD \cdot 1 \times 10^3 - Vf_x \cdot TSS}{A_w \cdot TSS} \right) \cdot \left(\frac{TSS \cdot 1 \times 10^{-6}}{C_{BS} \cdot d_{bs}} \right)$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-22	**k_b**	yr^{-1}	**1.219E-01**	--
CALC: B-4-13	**X_e**	kg/m^2-yr	2.29E+00	--
SITE SPECIFIC	**A_L** [1]	m^2	4.05E+04	--
CALC: B-4-14	**SD**	unitless	1.59E-01	--
SITE SPECIFIC	**Vf'_x** [2]	m^3/yr	0.00E+00	--
SITE SPECIFIC	**TSS** [3]	mg/L	1.63E+01	--
SITE SPECIFIC	**A_w** [4]	m^2	4.05E+03	--
SITE SPECIFIC	**C_{BS}** [5]	g/cm^3	1.00E+00	--
SITE SPECIFIC	**d_{bs}** [5]	m	3.00E-02	--

[1] A_L, Total Watershed Area (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[2] Volumetric Flow data (1997 - 2003) for Pee Dee watershed, HUC 03040201, Florence County, South Carolina, proportioned based on ratio of area of specific watershed to total watershed area (URL: www.waterdata.usgs.gov).

[3] Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

[4] $A_{w,}$ Area of Waterbody (m^2), calculated using ArcView 9.2 for the Pee Dee River "effective" watershed area (NHD geodatabase - NHDM0304.mdb).

[5] Table B-4-22, p. B-255, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005

TABLE B-4-23
TOTAL WATER COLUMN CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{wctot} = f_{wc} \cdot C_{wtot} \cdot \frac{d_{wc} + d_{bs}}{d_{wc}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-23	C_{wctot}	mg/L	**4.125E-08**	--
CALC: B-4-16	f_{wc}	unitless	3.49E-03	--
CALC: B-4-15	C_{wtot}	mg/L	1.16E-05	--
SITE SPECIFIC	d_{wc} [1]	m	2.00E+00	--
SITE SPECIFIC	d_{bs} [2]	m	3.00E-02	--

[1]Depth of water column - based on visual review of the Yadkin-Pee-Dee River Hydroclectric Project FERC NO., 2206 Water Resources Work Group (April 30, 2004).
[2]Table B-4-23, p. B-258, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE B-4-24
DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF DRINKING WATER AND FISH EQUATIONS)

$$C_{dw} = \frac{C_{wctot}}{1 + Kd_{sw} \cdot TSS \cdot 1 \times 10^{-6}}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Mercuric Chloride 7487-94-7	Methyl Mercury 22967-92-6
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	mg/L	**1.33E-08**	**2.35E-09**
COPC SPECIFIC	**% MeHg**[1]	%	85.00%	15.00%
CALC: B-4-23	C_{wctot}	mg/L	4.12E-08	--
COPC SPECIFIC	Kd_{sw}[2]	L/kg SS	1.00E+05	--
SITE SPECIFIC	**TSS**[3]	mg/L	1.63E+01	--

[1]Divalent Mercury speciation split in the water body is assumed 85% Hg^{2+} and 15% MHg as per HHRAP guidance. Section 2.3.5.3, p. 2 - 52, Chapter 2 of the Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

[2]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[3]Average TSS value based on US EPA, STORET database for station PD-028, Pee Dee River, HUC 3040201. Approach recommended as per email communication from David Chestnut, South Carolina Department of Health and Environmental Control to Maria Zufall, Trinity Consultants (10/08/2008).

TABLE B-4-27
FISH CONCENTRATION FROM BIOACCUMULATION FACTORS USING DISSOLVED PHASE WATER CONCENTRATION
(CONSUMPTION OF FISH EQUATIONS)

$$C_{fish} = C_{dw} \cdot BAF_{fish}$$

Concentration in fish based on the Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg fish tissue	**6.28E-03**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	mg/L	2.35E-09
COPC SPECIFIC	BAF_{fish}[1]	L/kg fish tissue	2.67E+06

[1]Table 1, Section 3.1.3.1.3, p. 21.,Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Median and Highest Background Concentration in Fish

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
SITE SPECIFIC	$C_{fish(median)}$[1]	mg/kg fish tissue	**8.90E-01**
SITE SPECIFIC	$C_{fish(highest)}$[1]	mg/kg fish tissue	**7.00E+00**

[1]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE B-5-1
AIR CONCENTRATION
(DIRECT INHALATION EQUATION)

$$C_a = Q_{(Hg0)} \cdot \left[Cyv F_v + (1 - F_v) \cdot Cyp \right]$$

For Elemental Mercury, F_v = 1.0, therefore:

$$C_a = Q_{(Hg0)} \cdot \left[Cyv \cdot F_v \right]$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: B-5-1	C_a	µg/m^3	**1.52E-07**
SOURCE AND COPC SPECIFIC	$Q_{(Hg0)}$[1]	g/s	1.33E-05
COPC SPECIFIC	F_v[2]	unitless	1.00E+00
COPC AND SOURCE SPECIFIC	Cyv[3]	µg-s/g-m^3	1.14E-02

[1]Q(Hg0) = Q (total mercury) * 0.8% (loss to Hg Global Cycle). Total mercury emission rate includes both Boilers (2*57.8 lbs = 115.6 lbs/yr).

[2]Fraction of mercury air concentration in vapor phase, includes consideration of global mercury cycle, based on Figure 2-1, Section 2.2.2 of mercury deposition and risk assessment report.

[3]Unitized yearly air concentration from vapor phase from AERMOD Runs.

TABLE C-1-4
COPC INTAKE FROM FISH

$$I_{fish} = C_{fish} \cdot CR_{fish} \cdot F_{fish}$$

Intake Based on Proposed Pee Dee Facility Emissions

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	**5.53E-06**
CALC: B-4-27	$C_{fish(Pee\ Dee)}$	mg/kg	6.28E-03
EXPOSURE PARAMETER	$CR_{fish(subsistence\ fisher\ child)}$ [1]	kg/kg fish tissue-day	8.80E-04
SITE SPECIFIC	F_{fish} [2]	unitless	1.00E+00

[1]Table B-4-5, p. B-191, Appendix B, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Intake Based on Median Background Concentration in the Little Pee Dee River [1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	**7.83E-04**
SITE SPECIFIC	$C_{fish(median)}$ [2]	mg/kg	8.90E-01

[1]I_{fish}, based on Subsistence Fisher Child consumption rate and F_{fish} = 1.0

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

Intake Based on Highest Background Concentration in the Little Pee Dee River [1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	**6.16E-03**
SITE SPECIFIC	$C_{fish(highest)}$ [2]	mg/kg	7.00E+00

[1]I_{fish}, based on Subsistence Fisher Child consumption rate and F_{fish} = 1.0

[2]Mercury concentration in fish selected as the highest value from the USEPA fish advisory database for the Little Pee Dee River (URL: http://oaspub.epa.gov/nlfwa/nlfwa.bld_qry?p_type=tisrpt&p_loc=on).

TABLE C-1-5
COPC INTAKE FROM DRINKING WATER

$$I_{dw} = \frac{C_{dw} \cdot CR_{dw} \cdot F_{dw}}{BW}$$

TYPE	COPC CAS NO. PARAMETERS	Methyl Mercury 22967-92-6
CALC: C-1-5	$I_{dw(Pee\ Dee)}$	**1.05E-10**
CALC: B-4-24	$C_{dw(Pee\ Dee)}$	2.35E-09
EXPOSURE PARAMETER	CR_{dw}[1]	6.70E-01
SITE SPECIFIC	F_{dw}[1]	1.00E+00
EXPOSURE PARAMETER	BW[1]	1.50E+01

[1]Table C-1-5, p. C-18, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

TABLE C-1-6
TOTAL DAILY INTAKE

$$I = I_{soil} + I_{ag} + I_{beef} + I_{milk} + I_{fish} + I_{pork} + I_{poultry} + I_{eggs} + I_{dw}$$

Intake Based on Emissions from Proposed Pee Dee Facility[1]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(Pee\ Dee)}$	mg/kg-day	**5.53E-06**
CALC: C-1-4	$I_{fish(Pee\ Dee)}$	mg/kg-day	5.53E-06
CALC: C-1-5	I_{dw}[1]	mg/kg-day	1.05E-10

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Median Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(median)}$	mg/kg-day	**7.83E-04**
CALC: C-1-4	$I_{fish(median)}$	mg/kg-day	7.83E-04

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

Intake Based on Highest Background Concentration in Pee Dee River[2]

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-6	$I_{(highest)}$	mg/kg-day	**6.16E-03**
CALC: C-1-4	$I_{fish(highest)}$	mg/kg-day	6.16E-03

[1] I_{ag}, I_{beef}, I_{milk}, I_{pork}, $I_{poultry}$, I_{eggs} are not considered to be exposure pathways for this risk assessment and not included in the overall ingestion for mercury. U.S. EPA indicates that the primary exposure route (99.9%) to methylmercury is from the ingestion of fish. Section 3.2.1.1, p. 27, Draft Guidance for Implementing the January 2001 Methylmercury Water Quality Criterion, August 2006.

TABLE C-1-8
HAZARD QUOTIENT (INDEX) : NONCARCINOGENS[1]

$$HQ = \frac{I \cdot ED \cdot EF}{RfD \cdot AT \cdot 365}$$

[1]The Hazard Index (HI) is equal to Hazard Quotient (HQ) since methlymercury is the only COPC for which an HQ is calculated.

Impact Based on Emissions from Proposed Pee Dee Facility

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$HQ_{subsistence\ fisher\ child\ (Pee\ Dee)}$	unitless	**5.30E-02**
CALC: C-1-6	$I_{(Pee\ Dee)}$	mg/kg-day	5.53E-06
EXPOSURE PARAMETER	ED[1]	yr	6
EXPOSURE PARAMETER	EF[1]	days/yr	350
COPC SPECIFIC	RfD[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	AT[1]	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Median Background Concentration in Little Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$HQ_{subsistence\ fisher\ child\ (median)}$	unitless	**7.51**
CALC: C-1-6	$I_{(median)}$	mg/kg-day	7.83E-04
EXPOSURE PARAMETER	ED[1]	yr	6
EXPOSURE PARAMETER	EF[1]	days/yr	350
COPC SPECIFIC	RfD[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	AT[1]	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

Impact based on the Highest Background Concentration in Little Pee Dee River

TYPE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
CALC: C-1-8	$HQ_{subsistence\ fisher\ child\ (highest)}$	unitless	**59.07**
CALC: C-1-6	$I_{(highest)}$	mg/kg-day	6.16E-03
EXPOSURE PARAMETER	ED[1]	yr	6
EXPOSURE PARAMETER	EF[1]	days/yr	350
COPC SPECIFIC	RfD[1]	mg/kg-day	0.0001
EXPOSURE PARAMETER	AT[1]	yr	6

[1]Table C-1-8, pp. C-26 and C-27, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

CUMULATIVE HAZARD QUOTIENT (INDEX): NONCARCINOGENS

Subsistence Fisher Child (Lake Scenario)

TYPE	SOURCE	COPC CAS NO. PARAMETERS	UNITS	Methyl Mercury 22967-92-6
INDIVIUAL	Proposed Pee Dee Facility Emissions	$HQ_{subsistence\ fisher\ child\ (Pee\ Dee)}$	unitless	5.30E-02
	Median Background Concentration	$HQ_{subsistence\ fisher\ child\ (median)}$	unitless	7.51
	Highest Background Concentration	$HQ_{subsistence\ fisher\ child\ (highest)}$	unitless	59.07
% CONTRIBUTION	Pee Dee Emissions % contribution to the cumulative impact (Median background concentration + Pee Dee Emissions)	%	unitless	0.70%
	Pee Dee Emissions % contribution to the cumulative impact (Highest background concentration + Pee Dee Emissions)	%	unitless	0.09%

TABLE C-2-2
INHALATION HAZARD QUOTIENT

$$HQ_{inh(i)} = \frac{EC * 0.001}{RfC}$$

$$EC = \frac{C_a \cdot EF \cdot ED}{AT \cdot 365\ days/year}$$

TYPE	COPC CAS NO. PARAMETERS	UNITS	Elemental Mercury 7439-97-6
CALC: C-1-5	**$HQ_{(inh)}$**	unitless	**1.32E-07**
CALC: C-1-5	**EC**	µg/m^3	1.46E-07
EXPOSURE PARAMETER	**RfC**[1]	mg/m^3	1.10E-03
CALC: B-5-1	**C_a**	µg/m^3	1.52E-07
SITE SPECIFIC	**EF**[2]	days/yr	3.50E+02
EXPOSURE PARAMETER	**ED**[2]	yr	6.00E+00
EXPOSURE PARAMETER	**AT**[2]	yr	6.00E+00

[1]Values based on HHRAP Companion Access Database for mercuric cholride, methylmercury (URL: http://www.epa.gov/epaoswer/hazwaste/combust/finalmact/ssra/05hhrapchemdat.mdb).

[2]Table C-2-2, pp. C-37 and C-38, Appendix C, Human Health Risk Assessment Protocol (HHRAP) by USEPA, September 2005.

APPENDIX C – DETAILED LANDUSE DISCUSSION

AERMOD meteorological data include landuse specific parameters. When processing the datasets in the preprocessing program, AERMET, the user must supply values for the albedo, Bowen ratio, and surface roughness. Each of these values varies with differing landuse and has an effect on the meteorological data that is used in AERMOD (especially the surface roughness length). The US EPA has recently released the AERSURFACE program, which estimates surface characteristics based on the National Land Cover Database, 1992 version (NLCD92).[78] The associated AERSURFACE User's Guide details new guidance on how to assign surface characteristics based on the updated landuse data.[79]

DHEC has recently updated the Columbia meteorological data to reflect the new AERSURFACE parameters and also the time period to 2002-2006.[80] DHEC utilized the monthly option for assigning seasons in AERSURFACE to allow the surface characteristics to more closely resemble the climate of the area. In addition to this seasonal characterization, DHEC also compared the total rainfall for each met data year (2002-2006) to the Palmer Drought Index in order to appropriately assign the surface moisture category (e.g. average, wet, dry). The seasonal mapping and soil moisture assignments utilized in data processing were provided by DHEC.[81] Table C-1 illustrates the seasonal categories utilized by DHEC in AERSURFACE to generate annual average values for each directional sector.

[78] http://www.epa.gov/scram001/dispersion_related.htm#aersurface

[79] US EPA, *AERSURFACE User's Guide*, EPA-454/B-08-001, January 2008.

[80] http://www.scdhec.net/environment/baq/modeling.aspx

[81] Email from Stephen Smutz (DHEC) to Jonathan Hill (Trinity) on July 2, 2008

TABLE C-1. SEASONAL CHARACTERIZATION UTILIZED IN AERSURFACE

Month	Seasonal Category
January	Late autumn after frost and harvest, or winter with no snow
February	Late autumn after frost and harvest, or winter with no snow
March	Transitional spring (partial green coverage, short annuals)
April	Transitional spring (partial green coverage, short annuals)
May	Midsummer with lush vegetation
June	Midsummer with lush vegetation
July	Midsummer with lush vegetation
August	Midsummer with lush vegetation
September	Midsummer with lush vegetation
October	Autumn with unharvested cropland
November	Autumn with unharvested cropland
December	Late autumn after frost and harvest, or winter with no snow

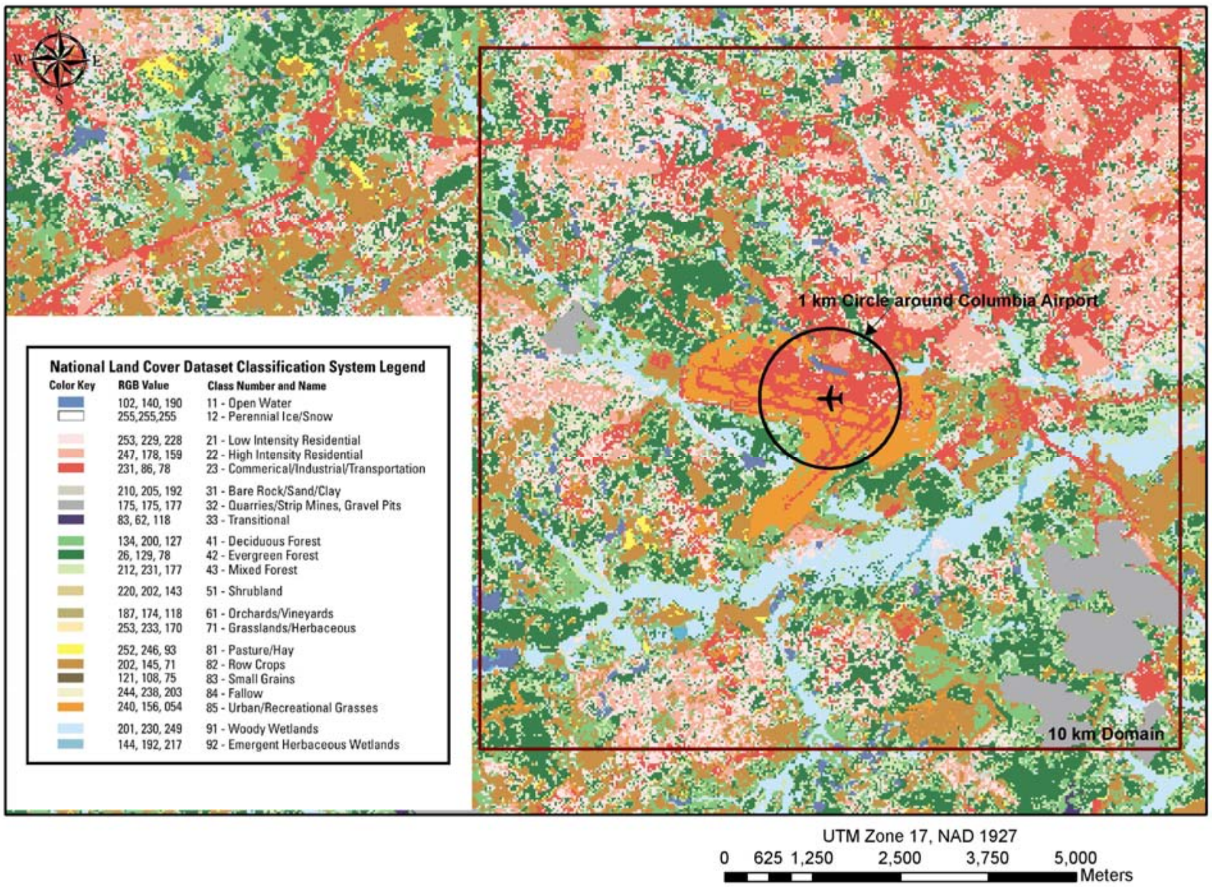
Table C-2 presents the surface characteristics that were used in the data processing for the area surrounding the Columbia airport. Using the Palmer Drought Index approach, 2002 was assigned a value of dry, 2003 was assigned a value of wet, and 2004-2006 were assigned values of average surface moisture.

TABLE C-2. SURFACE CHARACTERISTICS USED IN THE COLUMBIA MET DATA PROCESSING

Sector (deg)	Albedo (dimensionless)	Bowen Ratio (dimensionless) Dry Soil	Bowen Ratio (dimensionless) Average Soil	Bowen Ratio (dimensionless) Wet Soil	Surf. Roughness (m)
0-30	0.16	1.42	0.70	0.40	0.075
30-60	0.16	1.42	0.70	0.40	0.094
60-90	0.16	1.42	0.70	0.40	0.103
90-120	0.16	1.42	0.70	0.40	0.055
120-150	0.16	1.42	0.70	0.40	0.036
150-180	0.16	1.42	0.70	0.40	0.041
180-210	0.16	1.42	0.70	0.40	0.032
210-240	0.16	1.42	0.70	0.40	0.144
240-270	0.16	1.42	0.70	0.40	0.052
270-300	0.16	1.42	0.70	0.40	0.031
300-330	0.16	1.42	0.70	0.40	0.072
330-360	0.16	1.42	0.70	0.40	0.059

The AERSURFACE guidance document suggests that the surface roughness parameter be assigned a value based on the landuse over a 1 km radius surrounding the data collection site. This small radius of influence has made it more difficult to define true data representativeness, especially with regards to surface roughness which is the parameter to which AERMOD model concentrations are the most sensitive. The area immediately surrounding airport meteorological data sites is typically comprised of grasses, concrete and other landuse types with low surface roughness values. Figure C-1 illustrates the landuse for the area surrounding the Columbia airport. Note that most of the 1-km radius out from the meteorological data monitor is consumed by the airport grounds themselves, with only small forested areas in the southwest sector.

FIGURE C-1. LANDUSE SURROUNDING THE COLUMBIA AIRPORT



For new industrial sites, such as the proposed Pee Dee facility, the pre-construction landuse is often comprised of wooded areas, which have high surface roughness values. As such, the surface roughness comparison does not always show good agreement between airport and facility locations. The land will be cleared as part of early construction activities, such that the post-construction landuse will be much more similar to an airport location. Figure C-2 presents the landuse (1992 data) surrounding the facility location.

FIGURE C-2. LANDUSE SURROUNDING THE PEE DEE FACILITY

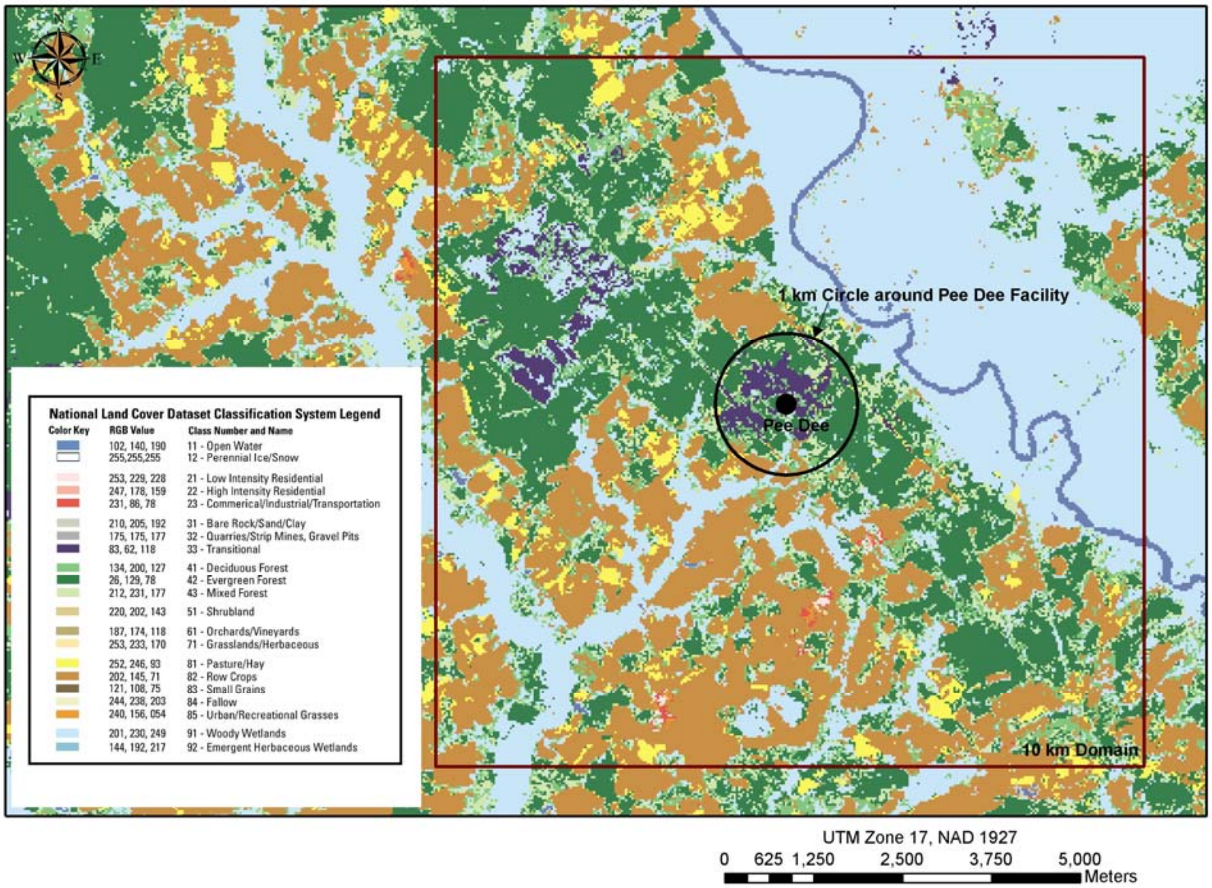


Table C-3 presents the surface characteristics that were used in the data processing for the area surrounding the Pee Dee facility, again based on the 1992 landuse dataset.

TABLE C-3. SURFACE CHARACTERISTICS USED IN THE PEE DEE FACILITY PROCESSING

Sector (deg)	Albedo (dimensionless)	Bowen Ratio (dimensionless) Dry Soil	Average Soil	Wet Soil	Surf. Roughness (m)
0-30	0.15	0.66	0.40	0.20	0.588
30-60	0.15	0.66	0.40	0.20	0.488
60-90	0.15	0.66	0.40	0.20	0.626
90-120	0.15	0.66	0.40	0.20	0.667
120-150	0.15	0.66	0.40	0.20	0.875
150-180	0.15	0.66	0.40	0.20	0.553
180-210	0.15	0.66	0.40	0.20	0.587
210-240	0.15	0.66	0.40	0.20	0.678
240-270	0.15	0.66	0.40	0.20	0.453
270-300	0.15	0.66	0.40	0.20	0.612
300-330	0.15	0.66	0.40	0.20	0.517
330-360	0.15	0.66	0.40	0.20	0.441

Given the qualitative and quantitative differences between the landuse distributions for the two sites, a comparison of the site-specific surface characteristics was made. The differences in the domain-averaged albedo and Bowen ratios range from 6% to 115%. AERMOD is most sensitive to changes in the surface roughness parameter and these differences are examined further in Table C-4.

TABLE C-4. SURFACE ROUGHNESS COMPARISON BETWEEN COLUMBIA AND PEE DEE

Sector (deg.)	Surface Roughness (m) CAE Airport	Pee Dee Facility	% Difference[1]
0-30	0.075	0.588	87.24%
30-60	0.094	0.488	80.74%
60-90	0.103	0.626	83.55%
90-120	0.055	0.667	91.75%
120-150	0.036	0.875	95.89%
150-180	0.041	0.553	92.59%
180-210	0.032	0.587	94.55%
210-240	0.144	0.678	78.76%
240-270	0.052	0.453	88.52%
270-300	0.031	0.612	94.93%
300-330	0.072	0.517	86.07%
330-360	0.059	0.441	86.62%
Domain Average	**0.066**	**0.590**	**88.43%**

[1] % Difference calculated as (Facility-Airport)/Facility

Given the differences in the surface roughness values, the mercury deposition analyses were performed using both the DHEC-provided meteorological data as well as the reprocessed data using the Pee Dee landuse parameters. The Pee Dee landuse data yielded the highest deposition values, and as such, those results were used in the risk analysis.

APPENDIX D – ELECTRONIC MODEL FILES

Santee Cooper Mercury Risk Assessment Modeling File Index

This CD-ROM contains all of the files used in the mercury (Hg) deposition analysis and risk assessment for Santee Cooper's proposed Pee Dee facility, located within the Pee Dee River Basin. The files contained in each of the folders are listed below.

1. AERMOD Comparative Analysis – This folder contains the files used in the AERMOD comparative analysis which was performed to ensure that the modified executable, which allows deposition calculations beyond 80km, yields identical results to the regulatory version. The modified AERMOD code used in the recompilation is contained in the .zip file found in this folder. The subfolders in this directory are as follow:

A. Modified Code Runs:

1. aermod.exe – recompiled AERMOD executable allowing deposition calculations for receptors greater than 80km from the source.

2. CAE_2003.*aaa* – the meteorological data files used in the analysis where;
   aaa is the file extension (sfc - surface file, pfl - profile file)

3. Hg(*bbb*)_Dep03.*ccc* – the AERMOD modeling files where;
   bbb is the pollutant ID (El – elemental Hg, II – divalent Hg, P – particulate Hg)
   ccc is the file extension (dat – AERMOD input file, lst – AERMOD output file, plt – AERMOD Plot file)

4. Hg_Dep.bat – batch file used to executed the speciated Hg runs in AERMOD

B. Regulatory Code Runs:

1. AERMOD_EPA_07026.exe – the regulatory executable for AERMOD

2. CAE_2003.*aaa* – the meteorological data files used in the analysis where;
   aaa is the file extension (sfc - surface file, pfl - profile file)

3. Hg(*bbb*)_Dep03.*ccc* – the AERMOD modeling files where;
   bbb is the pollutant ID (El – elemental Hg, II – divalent Hg, P – particulate Hg)
   ccc is the file extension (dat – AERMOD input file, lst – AERMOD output file, plt – AERMOD Plot file)

4. Hg_Dep.bat – batch file used to executed the speciated Hg runs in AERMOD

2. Downwash – This folder contains the BPIP PRIME input, output and summary files generated during the building downwash analysis. The files are named as follow:

BPIP.*aaa* – building downwash files where
   aaa is the file extension (inp – BPIP input file, out – BPIP output file, sum – BPIP summary file)

3. Met Data – This folder contains the 2002-2006 meteorological data files from Columbia, SC, based on the landuse surrounding the Pee Dee facility, which were used in the AERMOD modeling analyses. A 5 year file (02-06) was also generated to facilitate the refined analysis. The files are named as follow:

CAE_PD_LU_*yy*.zzz – the AERMOD ready met data files where;
   yy is the data year (02 – 2002, 03 – 2003, …, 06 – 2006)
   zzz is the fil extension (sfc – surface file, pfl – profile file)

4. Modeling Files – This folder contains the AERMOD input and output files that were used in both the screening and refined analyses. The subfolders in this directory are as follow:

A. Refined – This folder contains the AERMOD modeling files for the refined receptor grid. These runs were performed for the full 5-year modeling period to make the runs and post-processing more efficient.

1. Hg(*bbb*).*ccc* – the AERMOD modeling files where;
   - *bbb* is the pollutant ID (El – elemental Hg, II – divalent Hg, P – particulate Hg)
   - *ccc* is the file extension (dat – AERMOD input file, lst – AERMOD output file)

B. Screening - This folder contains the AERMOD modeling files for the full Pee Dee River Basin

1. Hg(bbb).zip - the AERMOD modeling files where;
   - *bbb* is the pollutant ID (El – elemental Hg, II – divalent Hg, P – particulate Hg)
   - a. Each zip file contains the AERMOD control files names as follows: Hg(*bbb*)_Dep*yy*.*ccc* where;
     - *bbb* is the pollutant ID (El – elemental Hg, II – divalent Hg, P – particulate Hg)
     - *yy* is the data year (02 – 2002, 03 – 2003, …, 06 – 2006)
     - *ccc* is the file extension (dat – AERMOD input file, lst – AERMOD output file)

5. Post-processing – This folder contains the spreadsheets that were used to sum the impacts of all three Hg species to a total Hg deposition value and average over the modeling domain.

A. Refined - contains the spreadsheet that was used to sum the impacts of all three Hg species to a total Hg deposition value and average over the refined receptor grid:

Avg_Hg_Deposition (57-8lb_yr, refined).xls

B. Screening - contains the spreadsheet that was used to sum the impacts of all three Hg species to a total Hg deposition value and average over the Pee Dee River Basin:

Avg_Hg_Deposition (57-8lb_yr, screening).xls